Official Bulletin
Graduate Studies
2018–2022

Arts, Sciences & Engineering
School of Arts & Sciences
Edmund A. Hajim School of Engineering & Applied Sciences
Eastman School of Music
School of Medicine and Dentistry
School of Nursing
Simon Business School
Margaret Warner Graduate School of Education and Human Development

The bulletin was prepared in the fall of 2017. Provisions of this publication are not to be regarded as an irrevocable contract between the student and the University. The University reserves the right to make changes in its course offerings, degree requirements, regulations and procedures, and fees and expenses as educational and financial considerations require.

Information in this bulletin does not apply to the MD Program in the School of Medicine and Dentistry.

EOE Minorities/Females/Protected Veterans/Disabled
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Publications about Graduate Programs at the University of Rochester

The Regulations and University Policies Concerning Graduate Studies is a separate document addressing central policies on enrollment, curriculum, and completion of graduate degrees. It is found at [www.rochester.edu/gradstudies/publications.html](http://www.rochester.edu/gradstudies/publications.html).

Most colleges and schools of the University publish brochures or digital files listing faculty, courses, and degree requirements. In addition, many departments offering graduate programs publish detailed brochures about their courses of study, faculty members, facilities, scholarships, etc. All graduate programs have valuable information on their websites.

Requests for information about the programs and how to apply should be made to the following:

<table>
<thead>
<tr>
<th>School of Arts &amp; Sciences</th>
<th>Office of Graduate Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departmental/Program brochures and online applications</td>
<td>University of Rochester</td>
</tr>
<tr>
<td></td>
<td>207 Lattimore Hall</td>
</tr>
<tr>
<td></td>
<td>Box 270401</td>
</tr>
<tr>
<td></td>
<td>Rochester, New York 14627-0401</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:graduate.admissions@rochester.edu">graduate.admissions@rochester.edu</a></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.rochester.edu/college/gradstudies">www.rochester.edu/college/gradstudies</a></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
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<td>Rochester, New York 14627-0401</td>
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<table>
<thead>
<tr>
<th>Eastman School of Music</th>
<th>Office of Admissions</th>
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</thead>
<tbody>
<tr>
<td>Graduate Studies at Eastman brochure and online application (Graduate and undergraduate)</td>
<td>Eastman School of Music</td>
</tr>
<tr>
<td></td>
<td>26 Gibbs Street</td>
</tr>
<tr>
<td></td>
<td>Rochester, New York 14604-3599</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:admissions@esm.rochester.edu">admissions@esm.rochester.edu</a></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.esm.rochester.edu/admissions">www.esm.rochester.edu/admissions</a></td>
</tr>
</tbody>
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<thead>
<tr>
<th>School of Medicine and Dentistry</th>
<th>Offices for Graduate Education and Postdoctoral Affairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departmental/Program brochures and online applications</td>
<td>School of Medicine and Dentistry</td>
</tr>
<tr>
<td></td>
<td>University of Rochester Medical Center</td>
</tr>
<tr>
<td></td>
<td>601 Elmwood Avenue, Box 316</td>
</tr>
<tr>
<td></td>
<td>Rochester, New York 14642-0001</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:gradadm@urmc.rochester.edu">gradadm@urmc.rochester.edu</a></td>
</tr>
<tr>
<td></td>
<td>University of Rochester</td>
</tr>
<tr>
<td></td>
<td>School of Medicine and Dentistry</td>
</tr>
<tr>
<td></td>
<td>Director of Admissions</td>
</tr>
<tr>
<td></td>
<td>Elmwood Avenue, Box 601A</td>
</tr>
<tr>
<td></td>
<td>Rochester, New York 14642-0001</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:mdadmish@urmc.rochester.edu">mdadmish@urmc.rochester.edu</a></td>
</tr>
<tr>
<td></td>
<td>AMCAS: <a href="http://www.aamc.org">www.aamc.org</a></td>
</tr>
<tr>
<td></td>
<td><strong>Official Bulletin</strong></td>
</tr>
<tr>
<td></td>
<td><strong>MD and MD/PhD programs</strong></td>
</tr>
</tbody>
</table>
| School of Nursing | Office of Student Affairs  
| School of Nursing  
| 601 Elmwood Avenue, Box SON  
| Rochester, New York 14642-0001  
| (585) 275-2375  
| [www.son.rochester.edu](http://www.son.rochester.edu) |
| **Simon Business School**  
| Detailed general brochure and brochures for Executive MBA and part-time programs  
| Executive and Professional Programs  
| Simon Business School  
| 204 Schlegel Hall  
| University of Rochester  
| Box 270107  
| Rochester, New York 14627-0107  
| (585) 275-1439  
| Email: [emba@simon.rochester.edu](mailto:emba@simon.rochester.edu) |
| Detailed general brochure and brochures for full-time MBA and MS programs  
| Admissions Office  
| Simon Business School  
| 245 Gleason Hall  
| University of Rochester  
| Box 270107  
| Rochester, New York 14627-0107  
| (585) 275-3533  
| Email: [admissions@simon.rochester.edu](mailto:admissions@simon.rochester.edu) |
| **PhD program**  
| PhD Office  
| Simon Business School  
| 4-308 Carol Simon Hall  
| University of Rochester  
| Box 270100  
| Rochester, New York 14627-0100  
| (585) 275-2959  
| Email: [phdoffice@simon.rochester.edu](mailto:phdoffice@simon.rochester.edu) |
| **Margaret Warner Graduate School of Education and Human Development**  
| Brochures for specific master's and doctoral degree programs and online applications  
| Admissions Office  
| Margaret Warner Graduate School of Education and Human Development  
| Raymond F. LeChase Hall  
| University of Rochester  
| Box 270425  
| Rochester, New York 14627-0425  
| (585) 275-3950  
| Email: [admissions@warner.rochester.edu](mailto:admissions@warner.rochester.edu)  
| [www.warner.rochester.edu](http://www.warner.rochester.edu) |
### 2018–2020 Calendar*

This calendar is prepared far in advance of publication. Some dates may change. For specific degree program deadlines (i.e., application deadlines, qualifying exam dates, dissertation deadlines), check with department and/or school graduate studies offices.

#### Spring Semester 2018

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 15</td>
<td>Martin Luther King Jr. Day observed.</td>
</tr>
<tr>
<td>January 17</td>
<td>Classes begin.</td>
</tr>
<tr>
<td>March 10</td>
<td>Spring recess begins. Classes resume March 19.</td>
</tr>
<tr>
<td>May 18–20</td>
<td>Commencement weekend.</td>
</tr>
</tbody>
</table>

#### Fall Semester 2018

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>August 29</td>
<td>Classes begin.</td>
</tr>
<tr>
<td>October 15</td>
<td>Fall term break. Classes resume October 17.</td>
</tr>
<tr>
<td>December 21</td>
<td>Winter recess begins after last examination.</td>
</tr>
</tbody>
</table>

#### Spring Semester 2019

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 21</td>
<td>Martin Luther King Jr. Day observed.</td>
</tr>
<tr>
<td>January 16</td>
<td>Classes begin.</td>
</tr>
<tr>
<td>March 9</td>
<td>Spring recess begins. Classes resume March 18.</td>
</tr>
<tr>
<td>May 17–19</td>
<td>Commencement weekend.</td>
</tr>
</tbody>
</table>

#### Fall Semester 2019

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>August 28</td>
<td>Classes begin.</td>
</tr>
<tr>
<td>October 14</td>
<td>Fall term break begins. Classes resume October 16.</td>
</tr>
<tr>
<td>November 27</td>
<td>Thanksgiving recess begins at noon. Classes resume December 2.</td>
</tr>
<tr>
<td>December 20</td>
<td>Winter recess begins after last examination.</td>
</tr>
</tbody>
</table>

*These dates do not apply to the Simon Business School or the Eastman School of Music. For additional information, please visit www.simon.rochester.edu or www.rochester.edu/eastman.*
# University of Rochester

## Senior Leadership Administration

*(as of May 2018)*

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richard Feldman</td>
<td>President (interim)</td>
</tr>
<tr>
<td>Robert L. Clark</td>
<td>Provost and Senior Vice President for Research</td>
</tr>
<tr>
<td>Andrew Ainslie</td>
<td>Dean, William E. Simon School of Business</td>
</tr>
<tr>
<td>Adam P. Anolik</td>
<td>Senior Vice President and Chief Financial Officer, University of Rochester Medical Center</td>
</tr>
<tr>
<td>Michael J. Apostolakos</td>
<td>Vice President and Chief Medical Officer, University of Rochester Medical Center</td>
</tr>
<tr>
<td>Jonathan Binstock</td>
<td>The Mary W. and Donald R. Clark Director of the Memorial Art Gallery</td>
</tr>
<tr>
<td>Raffaella Borasi</td>
<td>Dean and Frederica Warner Professor, Margaret Warner Graduate School of Education and Human Development</td>
</tr>
<tr>
<td>Jonathan Burdick</td>
<td>Vice Provost for Enrollment Initiatives and Dean of College Admission and Financial Aid</td>
</tr>
<tr>
<td>Paul J. Burgett</td>
<td>Vice President, Senior Advisor to the President, and University Dean</td>
</tr>
<tr>
<td>Michael Campbell</td>
<td>Director of the Laboratory for Laser Energetics</td>
</tr>
<tr>
<td>Holly G. Crawford</td>
<td>Senior Vice President for Administration and Finance, Chief Financial Officer, and Treasurer</td>
</tr>
<tr>
<td>Gloria Culver</td>
<td>Dean of the School of Arts &amp; Sciences</td>
</tr>
<tr>
<td>Mary Jane Curry</td>
<td>Faculty Senate Co-Chair; Associate Professor, Department of Teaching and Curriculum, Margaret Warner Graduate School of Education and Human Development</td>
</tr>
<tr>
<td>Teri D’Agostino</td>
<td>Chief of Staff to the University of Rochester Medical Center CEO and Dean of the School of Medicine and Dentistry; Vice President, University of Rochester Medical Center</td>
</tr>
<tr>
<td>Stephen Dewhurst</td>
<td>Vice Dean for Research, School of Medicine and Dentistry; Associate Vice President for Health Sciences Research; Professor and Chair of Microbiology and Immunology</td>
</tr>
<tr>
<td>Eli Eliav</td>
<td>Director, Eastman Institute for Oral Health; Vice Dean for Oral Health, School of Medicine and Dentistry</td>
</tr>
<tr>
<td>Thomas J. Farrell</td>
<td>Senior Vice President and James D. Thompson Chief Advancement Officer</td>
</tr>
<tr>
<td>Emily Cihon Fehnel</td>
<td>Deputy to the President</td>
</tr>
<tr>
<td>Jane Gatewood</td>
<td>Vice Provost for Global Engagement</td>
</tr>
<tr>
<td>Steven I. Goldstein</td>
<td>President and CEO, Strong Memorial Hospital and Highland Hospital; Vice President, University of Rochester Medical Center</td>
</tr>
<tr>
<td>Anthony M. Green</td>
<td>Deputy to the Provost</td>
</tr>
<tr>
<td>Donald Hall</td>
<td>Robert L. and Mary L. Sproull Dean of the Faculty of Arts, Sciences &amp; Engineering</td>
</tr>
<tr>
<td>Wendi B. Heinzelman</td>
<td>Dean, Edmund A. Hajim School of Engineering &amp; Applied Sciences</td>
</tr>
<tr>
<td>Margaret H. Kearney</td>
<td>Vice Provost and University Dean of Graduate Studies</td>
</tr>
<tr>
<td>Anthony D. Kinslow</td>
<td>Associate Vice President for Human Resources</td>
</tr>
<tr>
<td>David E. Lewis</td>
<td>Vice President for Information Technology and Chief Information Officer</td>
</tr>
<tr>
<td>Vivian Lewis</td>
<td>Deputy to the President and Vice Provost for Faculty Development and Diversity</td>
</tr>
<tr>
<td>Mary Ann Mavrinac</td>
<td>Vice Provost and Andrew H. and Janet Dayton Neilly Dean of the University of Rochester Libraries</td>
</tr>
<tr>
<td>Kevin McFarland</td>
<td>Faculty Senate Co-Chair; Professor of Physics, Arts, Sciences &amp; Engineering</td>
</tr>
<tr>
<td>Duncan T. Moore</td>
<td>Vice Provost for Entrepreneurship and Rudolf and Hilda Kingslake Professor of Optical Engineering</td>
</tr>
<tr>
<td>Lamar Riley Murphy</td>
<td>General Secretary and Chief of Staff</td>
</tr>
<tr>
<td>Gail M. Norris</td>
<td>Vice President and General Counsel</td>
</tr>
<tr>
<td>Douglas W. Phillips</td>
<td>Senior Vice President for Institutional Resources</td>
</tr>
<tr>
<td>Kathy H. Rideout</td>
<td>Vice President, University of Rochester Medical Center; Dean, School of Nursing</td>
</tr>
<tr>
<td>Peter G. Robinson</td>
<td>Vice President and Chief Operating Officer, University of Rochester Medical Center; Vice President for Government and Community Relations</td>
</tr>
<tr>
<td>Jamal J. Rossi</td>
<td>Joan and Martin Messinger Dean of the Eastman School of Music</td>
</tr>
<tr>
<td>Michael F. Rotondo</td>
<td>CEO, University of Rochester Medical Faculty Group; Vice Dean for Clinical Affairs, School of Medicine and Dentistry; Vice President for Administration, University of Rochester Medical Center</td>
</tr>
<tr>
<td>Jeffrey T. Runner</td>
<td>Dean of the College</td>
</tr>
<tr>
<td>Joan Saab</td>
<td>Vice Provost for Academic Affairs and Chair, Department of Art and Art History</td>
</tr>
<tr>
<td>Elizabeth Stauderman</td>
<td>Vice President for Communications</td>
</tr>
<tr>
<td>Melissa Sturge-Apple</td>
<td>Dean of Graduate Studies, Arts, Sciences &amp; Engineering</td>
</tr>
<tr>
<td>Mark B. Taubman</td>
<td>CEO, University of Rochester Medical Center and UR Medicine; Dean, School of Medicine and Dentistry; Senior Vice President for Health Sciences</td>
</tr>
<tr>
<td>Sasha Tulgan</td>
<td>Deputy to the President</td>
</tr>
<tr>
<td>Richard Waugh</td>
<td>Associate Vice President for Research and New Initiatives; Chair and Professor, Department of Biomedical Engineering</td>
</tr>
<tr>
<td>David R. Williams</td>
<td>Dean for Research in Arts, Sciences &amp; Engineering; Director of the Center for Visual Science; William G. Allyn Professor of Medical Optics</td>
</tr>
</tbody>
</table>
Graduate Education
The University of Rochester is an independent university that offers over 50 doctoral programs and over 200 master’s programs in the following schools:

- Arts, Sciences & Engineering
- School of Arts & Sciences
- Edmund A. Hajim School of Engineering & Applied Sciences
- Eastman School of Music
- School of Medicine and Dentistry
- School of Nursing
- Simon Business School
- Margaret Warner Graduate School of Education and Human Development

The first PhD degree was awarded in 1925, and one of the first three to earn the degree at the University later became a Nobel laureate. The University has been endowed by many benefactors, including George Eastman, founder of Eastman Kodak; Joseph Wilson, founder of Xerox; and Charles F. Hutchison.

In 2017–18, the University had nearly 1,300 tenure track faculty and roughly 9,700 full-time and 1,900 part-time students. Of the full-time students, 6,500 were undergraduates and 3,200 were graduate students.

The University of Rochester is accredited by the Middle States Commission on Higher Education, 3624 Market Street, Philadelphia, Pa. 19104. Phone: (267) 284-5000. University programs also are accredited by a number of agencies and associations. The full listing can be found at www.rochester.edu/provost/accreditation/.

Associated Educational Institutions
Colgate Rochester Crozer Divinity School-Bexley Hall-St. Bernard's School of Theology and Ministry is an interdenominational seminary offering graduate programs leading to professional degrees for the ministry. While it is geographically separated from the University by about one mile and is governed by its own independent boards, it is affiliated with the University in the sense that students in each institution can take courses in the other and use the libraries of both.

The George Eastman Museum: The University of Rochester and George Eastman Museum have a long history of collaboration in both teaching and research. In the 1970s, a joint University of Rochester-Eastman Museum committee received funding from the National Endowment for the Humanities to develop a film studies curriculum at the University using Eastman Museum archives. Since that time, teaching on both campuses by Rochester faculty and Eastman Museum curators has continued in the areas of film and media studies, art history, and other disciplines. Beginning in 2005, Rochester faculty and Eastman Museum personnel collaborated on a master’s degree in motion picture preservation.

Graduate Student Exchange Scholar Program: Cornell, Syracuse, and Rochester offer graduate students the opportunity, when the appropriate course or facility is unavailable in the home university, to take special courses and seminars and to use the libraries at the other two universities. Inasmuch as each university has unique courses and programs, this exchange considerably expands opportunities for some students. More information about this program is available in the Office of the University Dean of Graduate Studies.

University Council on Graduate Studies
The University Council on Graduate Studies is chaired by the University dean of graduate studies. The provost serves ex officio. Membership consists of the deans and associate deans of graduate study of Arts, Sciences & Engineering (School of Arts & Sciences and Edmund A. Hajim School of Engineering & Applied Sciences), Eastman School of Music, School of Medicine and Dentistry, School of Nursing, Simon Business School, and Margaret Warner Graduate School of Education and Human Development; and a faculty representative from each of the PhD degree-granting departments and programs across the University. The Steering Committee of the Council is composed of the deans and associate deans of graduate study.

The principal functions of the Council are to decide, on the basis of quality considerations, which departments shall be authorized to give work towards the PhD degree and to authorize or restrict, as necessary, the different PhD programs; to scrutinize the policies, standards, and facilities for work for the degree of Doctor of Philosophy throughout the University to ensure a minimum quality standard is met; and to make reports on the findings and recommendations to the provost and president. In performance of this function, the Council may engage scholars from other universities.

Upon nominations by the faculties or other authorized agencies in the several schools, the Council recommends to the provost for transmission to the Board of Trustees the candidates for the Doctor of Philosophy degree.

A Steering Committee of the Council, composed of the University dean of graduate studies and the dean or associate dean of graduate studies (or equivalent) of each school, advises the Council in the performance of its functions, exchanges information, and adjusts procedures in the schools to enable administrative uniformity as needed.
Graduate Student Life

Graduate and Family Housing

Information on graduate and family housing can be obtained from the University Apartments Office at (585) 275-5824 or by email at uapts@reslife.rochester.edu or at www.rochester.edu/reslife.

Eligibility for University housing is contingent on the individual being currently registered as a full-time graduate student or professional trainee of the University of Rochester. A lottery system is used to establish priority among qualified applicants.

The Office of Residential Life and Housing Services also operates the Community Living Program, which has listings of privately owned apartments, houses, and rooms. For more information on this program, phone (585) 275-1081 or email ochousing@reslife.rochester.edu or check the website at www.rochester.edu/reslife.

Family-Friendly Policies for Graduate Students

All of the schools at the University of Rochester provide accommodation for graduate students for the birth or adoption of children, as outlined in the policy found in the Regulations and University Policies Concerning Graduate Studies found at www.rochester.edu/gradstudies/publications.html. Students are encouraged to consult the specific administrative offices within their respective schools regarding tuition, fees, financial aid, and course credit details.

Health Care Services

Student Health Program

The University Health Service (UHS) provides a full range of confidential, high-quality primary health care, mental health care, and health promotion services for all full-time University students on a prepaid basis through the Student Health Program. The University Health Service and the University Counseling Center are accredited by the Accreditation Association for Ambulatory Health Care (AAAHC). Information about services offered by the University Health Service and the University Counseling Center is available on the UHS website at www.rochester.edu/uhs.

Health Plan: All full-time students participate in the student health plan. The health plan has two parts. (1) Mandatory health fee: covers unlimited primary care visits with the physicians, nurse practitioners, and registered nurses at the University Health Service; assessment, brief treatment, and referral services with mental health professionals at the University Counseling Center; health promotion programs and services; and public health surveillance. All full-time students must pay the mandatory health fee, which entitles them to use the University Health Service and the University Counseling Center throughout the academic year and the following summer (August 1 to July 31), as long as they are enrolled on a full-time basis. (2) Health insurance: for services such as surgical procedures, hospitalization, diagnostic laboratory tests and X-rays, visits to specialists, and prescription medications. These services are not covered by the mandatory health fee.

All full-time students must have health insurance in addition to the mandatory health fee. Students can enroll in the University-sponsored health insurance plan or they can waive the insurance if they are covered by health insurance that meets University criteria.

Immunization Requirement: Entering full-time and part-time students must provide immunization information to meet New York State and University immunization requirements. These requirements, which are documented on the Health History Form (HHF), should be completed before arrival on campus. According to New York State law, failure to show proof of immunity to measles, mumps, and rubella will result in students not being allowed to attend classes at the University. For detailed information about the immunization requirements, check “Health Requirements for Entering Students” on the UHS website (www.rochester.edu/uhs). Also, on the same page, see Health History Form FAQs to answer questions about completing the Health History Form. If your question is not answered in the FAQs, write to hhf@uhs.rochester.edu for assistance.

University Health Service (UHS)

UHS provides a full range of primary health care services, including the treatment of illnesses and injuries, women’s health care, the management of ongoing medical problems, and advice and treatment for any health concern. In addition, UHS provides allergy injections, immunizations, for travel and other vaccines (e.g., flu shots, HPV vaccine, Hepatitis B vaccine), physical therapy, laboratory testing, referrals to specialists, and health education. Visits to the University Health Service are covered by the mandatory health fee that all full-time students pay. For more information about services for full-time students, check the UHS website at www.rochester.edu/uhs.

Confidentiality

The relationship between health care providers and their patients is confidential. Notification of others, including parents, friends, and University faculty and administration, is generally considered the student’s responsibility unless the condition is life threatening and the student is unable to assume responsibility for informing others. We will not share information about the fact or the nature of a student’s visit to UHS without the student’s permission.

UHS Website (www.rochester.edu/uhs)

The UHS website provides detailed information about the services provided by the University Health Service, the University Counseling Center, and the UHS Health Promotion Office.

University Counseling Center (UCC)

Any student initiating services at the University Counseling Center (UCC) can expect a comprehensive mental health assessment, an individualized treatment plan, and support for implementing such a plan. Same-day consultations are available for students who are in immediate crisis or at risk of hurting themselves or others.

Students utilize UCC services due to a variety of concerns, including anxiety, depression, apprehension about major life decisions or transitions, relationship difficulties, family problems, body image and eating, grief, sexual and gender identity, sexual
functioning, substance use, and general discomfort about what is happening in their lives.

A student’s individualized treatment plan may involve one or more of the following recommendations: group therapy at UCC, brief individual therapy at UCC, TAO (therapy assisted online) at UCC, referral for longer-term therapy or specialized treatment with a mental health provider in the community, psychiatry services at UCC/UHS, referral to other campus resources, referral to case management at UCC.

Staff members are also available to discuss topics or concerns of special interest to groups of students, to consult with members of the University community about students of concern, and to develop and coordinate mental health–related educational programming.

The therapists at the University Counseling Center are licensed professionals and professionals-in-training from a variety of mental health disciplines. They employ many treatment approaches and draw upon a wide range of training and experience in the field of psychotherapy. Psychiatrists are available within UCC/UHS to provide prescription medication in conjunction with therapy.

Confidentiality
All contacts with a University Counseling Center therapist are confidential. The fact that students are using UCC will not be disclosed to any University official or faculty member, or to family, friends, or roommates without the permission of the students. UCC will not release any clinical information about students’ visits, even with the students’ written request, except to another therapist for purposes of further treatment. In addition, because of the sensitive nature of visits, extreme care is taken to protect the confidentiality of our records. UCC records are separate from Strong Memorial Hospital medical records.

Urgent Situations and After-Hours Care
The University Counseling Center offers on-call emergency service 24 hours a day throughout the year for students who are in urgent distress themselves or who are concerned about someone else. The professional-on-call can be reached by calling (585) 275-3113.

UCC Website (www.rochester.edu/ucc)
The UCC website provides information about the center’s locations, hours, services, staff, online assessments and resources, and more.

Student Support
Disabilities
A student seeking reasonable accommodations on the basis of a disability should contact the Access Coordinator in the relevant school. The Access Coordinators for all schools as well as other relevant disability-related information including documentation guidelines are listed at www.rochester.edu/disability/access-coordinators.html.

Students who have questions or concerns who want to discuss them with someone outside the school may contact the Director of Disability Resources at (585) 279-9049.

A number of University-wide resources are available for students with disabilities and the faculty and staff who support them. The Director of Disability Resources works closely with the Access Coordinators in each of the schools to verify documentation of the existence of a disability, implement reasonable classroom accommodations, coordinate support services, and identify campus resources.

Conflict Resolution: University Intercessor
The goal of the intercessor is to promote a respectful, inclusive University for all members of the community by resolving disputes, challenging perceptions, and advocating for fairness at the University. For over 40 years, University Intercessors, appointed by the provost, have been untangling complex problems and unresolved interpersonal and departmental issues with staff, faculty, and students who call on them for help.

Students who have concerns that cannot be resolved through other channels are encouraged to contact an intercessor for confidential assistance at (585) 275-9125 or www.rochester.edu/intercessor/solving.html. The intercessor can help with concerns regarding discrimination and harassment, disability issues, and unresolved disagreements among faculty, staff, and students. All consultations are confidential.

International Services Office
The International Services Office (ISO) provides a full range of programs and services throughout the University for over 3,500 international students and 480 scholars and employees plus their dependents from more than 115 countries. The staff administers the F-1, J-1, H-1B, O-1, and TN visa programs for the University under specific government regulations. The staff of the ISO issues visa eligibility documents, provides advice on immigration regulations affecting international populations, and processes immigration benefits such as employment authorizations and extensions of stay.

The ISO acts as the University’s official liaison with the U.S. Department of Homeland Security, the Student and Exchange Visitor Program (SEVP), the Department of State, as well as foreign and American consulates and embassies. Locally, the ISO provides support and collaboration with government agencies including the Social Security Administration, Internal Revenue Service, and Department of Motor Vehicles. The office works closely with members of the University community to advocate for and address various needs of international students and scholars.

The ISO also serves as an information resource to help international populations in adjusting to the United States, the University, and the Rochester community. Services and programs include a comprehensive website and online resources (www.iso.rochester.edu); electronic newsletters; TIPS On-Demand video tutorials (available through Blackboard); orientation programs for new arrivals and logistical support with government forms, taxes, and reporting requirements; and instructional workshops throughout the year. Additionally, advising appointments are provided to assist individuals in effectively coping with personal challenges, legal concerns, and cultural adjustment. In order to promote intercultural understanding on
our campuses, the ISO also contributes to cultural, social, and educational programming efforts within the University and the Rochester community.

The International Services Office is located in 213 Morey Hall on the River Campus. For more information or to contact ISO staff, please call (585) 275-2866 or send an email to questions@iso.rochester.edu.

Health and Safety

Policy: It is the policy of the University of Rochester to provide an environment free from recognized hazards that could cause injury or illness to faculty, staff, students, patients, and visitors, and to protect its facilities from risk of damage from unsafe acts or conditions.

The Environmental Health and Safety Department is responsible for fire safety through the Fire Marshal’s Office; food safety through the Sanitarian’s Office; pest control through the Pest Control Unit; occupational safety and health through the Occupational Safety Unit; laboratory safety through the Laboratory Safety Unit: chemical waste disposal and environmental compliance through the Environmental Compliance Unit; and radiation safety issues through the Radiation Safety Unit.

Department of Public Safety

The University of Rochester’s annual fire and safety reports include statistics for the previous three years concerning fire incidents and reported crimes that occurred on campus; in certain off-campus buildings owned or controlled by the University; and on public property within, or immediately adjacent to and accessible from, the University’s campuses. The report also includes institutional policies regarding campus security, fire safety, alcohol and drug use, crime prevention, the reporting of crimes, sexual assault, and other matters. The report can be found at www.publicsafety.rochester.edu. Crime statistics can also be obtained from the Advisory Committee on Campus Safety by calling (585) 275-7814 and from the United States Department of Education on the web at www.ope.ed.gov/security/.

The University of Rochester prohibits discrimination on the basis of sex, including acts of sexual harassment, sexual assault, dating and domestic violence and stalking. Information on the policies and procedures related to this prohibited behavior can be found online at www.rochester.edu/eoc/index.html and by contacting Morgan Levy, the Title IX Coordinator for the University, by phone at (585) 275-7814 or via email at Morgan.Levy@rochester.edu.

How to Contact Public Safety

The University maintains an extensive network of over 500 interior and exterior public access telephones. You can call the Public Safety Communications Center for assistance any time of the day or night from any of these phones. Included are over 185 direct-dial Blue Light Emergency Phones.

In an EMERGENCY, dial x13 from any University phone, including service phones located at building entrances, or dial #413 from AT&T or Verizon cell phones. Or pick up a Blue Light Emergency Phone located along pedestrian pathways and parking areas, and you will be connected to one of our emergency dispatchers automatically. An officer will be sent to your location right away. Local police, fire, or ambulance agencies will be notified as needed. (Currently, if you call 911 from within the University phone system, your exact location will not be displayed to the 911 system operator.)

For nonemergencies, dial (585) 275-3333. You may also use a Blue Light Emergency Phone.

The dispatcher will determine first that you are safe. Once that is known, you will be asked for your name and location as well as descriptive information about the incident or event in which you are involved. This information will assist the responding officer(s) and other emergency responders.

You may contact an on-duty supervisor, 24 hours a day, by calling (585) 275-3333.

For crime prevention services, call (585) 275-2220. For investigative services, call (585) 275-3436.

Where to Find Public Safety

Our main office is located at the University Public Safety Center, 612 Wilson Boulevard. Office hours are 8:30 a.m. to 5 p.m. weekdays. Call (585) 275-3340 or (585) 275-3437, fax (585) 275-0144, or send email to 4_info@security.rochester.edu for more information. Our website is www.publicsafety.rochester.edu.

We are located in the Medical Center in Room G-6009 (near the bookstore and bank). Office hours are 8:30 a.m. to 5 p.m. weekdays. Call (585) 275-2221 or fax (585) 271-4513.

We are available to meet with students at the Eastman School of Music. We have space in the ESM main hall and in the main lobby of the Student Living Center. Call (585) 273-4200.

Public Safety Telephone Numbers to Remember

- EMERGENCY (from any University telephone): 13
- EMERGENCY (from any other telephone): (585) 275-3333
- EMERGENCY (from AT&T or Verizon cell phones): #413
- Nonemergencies: (585) 275-3333
- Eastman Office: (585) 273-5200
- Medical Center Office: (585) 275-2221
- Administrative and Patrol Operations Staff: (585) 275-3340
- General Information (email): publicsafety@rochester.edu
- Special Events: (585) 275-1087
- Lost/Found Property: (585) 275-2552

For more information, please visit our website at www.publicsafety.rochester.edu.

University Maps

Maps of all of the University’s campuses are available for students both online and in printed form. Go to www.rochester.edu/maps for the online versions. To request a printed map, please contact Creative Services at creativeservices@rochester.edu.
### Financial Information

#### Tuition and Fees

Graduate tuition at Rochester pays only a portion of actual educational costs. The balance is met by income from endowment and by support from individuals, foundations, corporations, and governments.

A full listing of Tuition and Fees can be viewed on the Bursar’s Office website at [www.rochester.edu/adminfinance/bursar/charges.htm](http://www.rochester.edu/adminfinance/bursar/charges.htm).

#### 2017–2018 Schedule of Charges for Graduate Studies

<table>
<thead>
<tr>
<th>School or College</th>
<th>Tuition Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts &amp; Sciences</td>
<td></td>
</tr>
<tr>
<td>Matriculated</td>
<td>$1,596/credit hour</td>
</tr>
<tr>
<td>Nonmatriculated</td>
<td>$1,022/credit hour</td>
</tr>
<tr>
<td>Engineering &amp; Applied Sciences</td>
<td>$1,596/credit hour</td>
</tr>
<tr>
<td>Technical Entrepreneurship &amp;</td>
<td>$1,875/credit hour</td>
</tr>
<tr>
<td>Management</td>
<td></td>
</tr>
<tr>
<td>Warner Graduate School of Education</td>
<td>$1,400/credit hour</td>
</tr>
<tr>
<td>School of Medicine and Dentistry</td>
<td>$1,596/credit hour</td>
</tr>
<tr>
<td>School of Nursing</td>
<td>$1,456/credit hour</td>
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</table>

<table>
<thead>
<tr>
<th>School or College</th>
<th>Audit Fee</th>
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</thead>
<tbody>
<tr>
<td>Arts &amp; Sciences, Education,</td>
<td>$184/credit hour</td>
</tr>
<tr>
<td>Engineering, Technical</td>
<td></td>
</tr>
<tr>
<td>Entrepreneurship &amp; Management,</td>
<td>$184/credit hour</td>
</tr>
<tr>
<td>and School of Medicine &amp; Dentistry</td>
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</table>

<table>
<thead>
<tr>
<th>Registration Fees</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>895 Continuation of Master’s</td>
<td>$1,070/semester</td>
</tr>
<tr>
<td>Enrollment (no health fees charged)</td>
<td></td>
</tr>
<tr>
<td>899 Master’s Dissertation</td>
<td>$1,070/semester</td>
</tr>
<tr>
<td>985 Leave of Absence</td>
<td>$60/semester</td>
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<table>
<thead>
<tr>
<th>Other Fees</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>Activity Fee: Arts &amp; Sciences,</td>
<td>$10/semester</td>
</tr>
<tr>
<td>Engineering, and Nursing</td>
<td></td>
</tr>
<tr>
<td>Program Fee: Technical Entrepreneurship &amp; Management</td>
<td>$250/semester</td>
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<tr>
<td>Part-time Student Health Record</td>
<td>$30</td>
</tr>
<tr>
<td>Processing Fee</td>
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</tr>
<tr>
<td>International Student Fee†</td>
<td>$25/semester</td>
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<table>
<thead>
<tr>
<th>Health and Insurance Fees</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory Health Fee: All full-time students</td>
<td>$300/semester</td>
</tr>
<tr>
<td>Health Insurance†</td>
<td></td>
</tr>
<tr>
<td>Fall semester</td>
<td>$1,146</td>
</tr>
<tr>
<td>Spring semester</td>
<td>$1,146</td>
</tr>
<tr>
<td>Child</td>
<td>$2,292/year</td>
</tr>
<tr>
<td>Two+ Children</td>
<td>$4,584/year</td>
</tr>
</tbody>
</table>

**Payment Policy**

For nonmatriculated students, 100 percent of the amount due the University for a semester is due at the time of registration. For matriculated students and students enrolled in the Simon Business School, the University offers a two-payment plan option each semester/quarter. If you miss the payment deadline, 1 percent of the balance due for the month will be charged as a late fee. For additional information, students should contact the Bursar’s Office, University of Rochester, Rochester, New York 14627-0037; or (585) 275-3931. Students in the School of Medicine and Dentistry should contact the Bursar’s Office, School of Medicine and Dentistry, 601 Elmwood Avenue, Rochester, New York 14642-8601; or (585) 275-4672.

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* Separate schedules are available for the Eastman School of Music, the School of Nursing, and the Simon Business School.

† F or J visa type

‡ The fall semester cost represents coverage for August–January; the spring semester cost represents coverage for February–July.
**Tuition Refund Policy**

Students’ official withdrawal or inactive date is determined when they formally change their status with their college’s Dean’s Office. It is this official “Change of Status” form that alerts the Registrar, Bursar’s Office, Financial Aid, and other appropriate offices to adjust the student’s accounts. Refund schedules are available on the Bursar’s website. Students declaring withdrawal or inactive status for medical reasons or other extraordinary circumstances may be granted prorated charges throughout the term with the approval of their college’s dean.

**Adjustments to Financial Aid**

Federal regulations determine how the Financial Aid Office calculates the adjustments to financial aid to reflect reduced tuition and fees. These regulations do not permit a proration of aid in the same manner that is charged for tuition and fees. Any credit balance created by reduced charges must first be used to repay federal aid, next to state aid, third to the institution’s aid programs, and finally to the student.

If an adjustment to financial aid is received, financial aid awards will be reduced in the following order: Unsubsidized Federal Direct Loans followed by any Federal PLUS Loans on the student account. Additional adjustments may be made to any awarded state aid, private educational loans, and/or institutional aid based on the student’s withdrawal date.

Examples of refund calculations for students receiving financial aid are available to review at the Financial Aid Office. If a student is considering withdrawing or taking inactive status, he or she should consult with a counselor in the Financial Aid Office to review the examples.

The Bursar’s Office and the Financial Aid Office will work together after receiving an official Change of Status notice from the Dean’s Office to determine these adjustments. Every attempt will be made to complete the refund calculation within 30 days of the change of status.

**Financial Awards**

Many students are able to pursue graduate studies by receiving financial aid from the University. Students should also apply for fellowships granted by private foundations, the federal government (e.g., the National Science Foundation), and by various state organizations.

It is the responsibility of all graduate students to inform Financial Aid Office of aid they receive from non-University sources.

**Graduate Fellowships and Assistantships**

The schools of the University award a large number of fellowships, assistantships, and scholarships to help graduate students meet the cost of education. Whether the funds for these awards come ultimately from individuals, corporations, foundations, government agencies, or the University itself, the amount and nature of the awards are decided by officers of the University.

Awards are made for various periods of time, and all awards are contingent upon satisfactory academic progress. Awards may be terminated at any time if academic performance is unsatisfactory.

Students also may apply for and win individual fellowships from agencies external to the University, such as NIH, NSF, and foundations. For those fellowships awarded directly to students from non-University sources, such as foundations or government agencies, the term of the grant is up to the donor. Nevertheless, holders of non-University fellowships may be terminated from a degree program during the term of the award if they do not maintain satisfactory academic standing.

Graduate fellowships are intended to further the recipients’ education and recipients are expected to devote full time to their studies and to any required teaching, research, or training.

**Acceptance of Departmental Financial Assistance**

The University of Rochester, as a member of the Council of Graduate Schools in the United States, subscribes to the following statement, which has been adopted by most of the leading graduate schools in North America, and interprets it as applying to master’s and doctoral students in programs with a fall start date:

“Acceptance of an offer of financial support (such as a graduate scholarship, fellowship, traineeship, or assistantship) for the next academic year by a prospective or enrolled graduate student completes an agreement that both student and graduate school expect to honor. In that context, the conditions affecting such offers and their acceptance must be defined carefully and understood by all parties.

“Students are under no obligation to respond to offers of financial support prior to April 15; earlier deadlines for acceptance of such offers violate the intent of this Resolution. In those instances in which a student accepts an offer before April 15, and subsequently desires to withdraw that acceptance, the student must submit in writing a resignation of the appointment at any time through April 15. However, an acceptance given or left in force after April 15 commits the student not to accept another offer without first obtaining a written release from the institution to which a commitment has been made. Similarly, an offer by an institution after April 15 is conditional on presentation by the student of the written release from any previously accepted offer. It is further agreed by the institutions and organizations subscribing to the above Resolution that a copy of this Resolution should accompany every scholarship, fellowship, traineeship, and assistantship offer.”

**Financial Assistance**

**Federal Aid Program:** Graduate students may borrow an unsubsidized loan through the Federal Direct Loan program. Students must be a citizen or eligible non-citizen, registered for at least part-time (minimum 6 credit hours) status, and be matriculated in a degree-seeking program to receive these loans. The actual amount a student is eligible to borrow cannot exceed the University of Rochester’s cost of attendance minus any other assistance received (including departmental awards).
Graduate Degrees Approved by New York State to Be Offered by the University in 2018

The University offers the following graduate degrees: Master of Arts, Master of Arts in Teaching, Master of Business Administration, Master of Music, Master of Public Health, Master of Science, Doctor of Education, Doctor of Medicine, Doctor of Musical Arts, Doctor of Nursing Practice, and Doctor of Philosophy. Certificates of advanced study also are offered in some schools.

The several hundred graduate-level programs approved by the New York State Education Department as of June 2017 are listed below. A current list of approved programs can be found at www.rochester.edu/provost/ir/inventory.html.

Some programs registered by the State may not be available for enrollment due to faculty changes and other factors. More detailed information about specific graduate programs is available elsewhere in this bulletin, at www.rochester.edu/gradstudies, and at program websites.

School of Arts & Sciences

<table>
<thead>
<tr>
<th>Program Code</th>
<th>Hegis Code</th>
<th>Program Name</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>10614</td>
<td>0401</td>
<td>Biology</td>
<td>MS</td>
</tr>
<tr>
<td>77802</td>
<td>4902</td>
<td>Biology-Geology</td>
<td>MS</td>
</tr>
<tr>
<td>10613</td>
<td>0401</td>
<td>Biology</td>
<td>PHD</td>
</tr>
<tr>
<td>20208</td>
<td>2002</td>
<td>Brain and Cognitive Sciences</td>
<td>MA</td>
</tr>
<tr>
<td>20207</td>
<td>2002</td>
<td>Brain and Cognitive Sciences</td>
<td>PHD</td>
</tr>
<tr>
<td>10765</td>
<td>1905</td>
<td>Chemistry</td>
<td>MS</td>
</tr>
<tr>
<td>09315</td>
<td>1905</td>
<td>Chemistry</td>
<td>PHD</td>
</tr>
<tr>
<td>10696</td>
<td>1504</td>
<td>Classics</td>
<td>MA</td>
</tr>
<tr>
<td>10701</td>
<td>1503</td>
<td>Comparative Literature</td>
<td>MA</td>
</tr>
<tr>
<td>10695</td>
<td>1503</td>
<td>Comparative Literature</td>
<td>PHD</td>
</tr>
<tr>
<td>37829</td>
<td>1505</td>
<td>Computational Linguistics</td>
<td>MS</td>
</tr>
<tr>
<td>10800</td>
<td>2204</td>
<td>Economics</td>
<td>MA</td>
</tr>
<tr>
<td>10799</td>
<td>2204</td>
<td>Economics</td>
<td>PHD</td>
</tr>
<tr>
<td>10734</td>
<td>1501</td>
<td>English</td>
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<tr>
<td>10733</td>
<td>1501</td>
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<tr>
<td>10607</td>
<td>0420</td>
<td>Environmental Studies</td>
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</tr>
<tr>
<td>10700</td>
<td>1102</td>
<td>French Language or Literature</td>
<td>MA</td>
</tr>
<tr>
<td>14383</td>
<td>4903</td>
<td>General Studies-Humanities</td>
<td>MS</td>
</tr>
<tr>
<td>10778</td>
<td>1914</td>
<td>Geological Sciences</td>
<td>MS</td>
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<tr>
<td>10777</td>
<td>1914</td>
<td>Geosciences</td>
<td>PHD</td>
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<tr>
<td>10708</td>
<td>1103</td>
<td>German Language or Literature</td>
<td>MA</td>
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<tr>
<td>10801</td>
<td>2205</td>
<td>History</td>
<td>MA</td>
</tr>
<tr>
<td>10803</td>
<td>2205</td>
<td>History</td>
<td>PHD</td>
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Hajim School of Engineering & Applied Sciences

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<th>Program Code</th>
<th>Hegis Code</th>
<th>Program Name</th>
<th>Degree</th>
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</thead>
<tbody>
<tr>
<td>33442</td>
<td>0906</td>
<td>Alternative Energy</td>
<td>MS</td>
</tr>
<tr>
<td>20578</td>
<td>0905</td>
<td>Biomedical Engineering</td>
<td>MS</td>
</tr>
<tr>
<td>10659</td>
<td>0905</td>
<td>Biomedical Engineering</td>
<td>PHD</td>
</tr>
<tr>
<td>10660</td>
<td>0906</td>
<td>Chemical Engineering</td>
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</tr>
<tr>
<td>10661</td>
<td>0906</td>
<td>Chemical Engineering</td>
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<tr>
<td>77107</td>
<td>0701</td>
<td>Computer Science</td>
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<tr>
<td>77359</td>
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<td>Computer Science</td>
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<tr>
<td>37172</td>
<td>0799</td>
<td>Data Science</td>
<td>MS</td>
</tr>
<tr>
<td>10665</td>
<td>0909</td>
<td>Electrical Engineering</td>
<td>MS</td>
</tr>
<tr>
<td>10664</td>
<td>0909</td>
<td>Electrical Engineering</td>
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### Hajim School of Engineering & Applied Sciences

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<thead>
<tr>
<th>Program Code</th>
<th>Hegis Code</th>
<th>Program Name</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>80164</td>
<td>0909</td>
<td>Electrical and Computer Engineering</td>
<td>MS*</td>
</tr>
<tr>
<td>14804</td>
<td>4904</td>
<td>General Studies-Materials Engineering</td>
<td>MS</td>
</tr>
<tr>
<td>10671</td>
<td>0915</td>
<td>Materials Science</td>
<td>MS</td>
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<tr>
<td>10670</td>
<td>0915</td>
<td>Materials Science</td>
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<tr>
<td>10666,</td>
<td>20445</td>
<td>Mechanical Engineering</td>
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<tr>
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<td>0910</td>
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<td>PHD</td>
</tr>
<tr>
<td>10675</td>
<td>0999</td>
<td>Optics</td>
<td>MS</td>
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<tr>
<td>10674</td>
<td>0999</td>
<td>Optics</td>
<td>PHD</td>
</tr>
<tr>
<td>37453</td>
<td>0499</td>
<td>TEAM: Biomanufacturing &amp; Therapeutic Development</td>
<td>MS</td>
</tr>
<tr>
<td>33043</td>
<td>0901</td>
<td>Technical Entrepreneurship and Management</td>
<td>MS</td>
</tr>
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</table>

### Eastman School of Music

<table>
<thead>
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<th>Hegis Code</th>
<th>Program Name</th>
<th>Degree</th>
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</thead>
<tbody>
<tr>
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<td>1004</td>
<td>Conducting</td>
<td>MM</td>
</tr>
<tr>
<td>81254</td>
<td>1004</td>
<td>Conducting</td>
<td>DMA</td>
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<tr>
<td>29675</td>
<td>1004</td>
<td>Early Music</td>
<td>MM</td>
</tr>
<tr>
<td>29674</td>
<td>1004</td>
<td>Early Music</td>
<td>DMA</td>
</tr>
<tr>
<td>29320</td>
<td>1006</td>
<td>Ethnomusicology</td>
<td>MA</td>
</tr>
<tr>
<td>29320</td>
<td>1006</td>
<td>Ethnomusicology</td>
<td>MA*</td>
</tr>
<tr>
<td>78126</td>
<td>1004</td>
<td>Jazz Studies &amp; Contemporary Media</td>
<td>MM</td>
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#### Accelerated Master’s Programs for Non-Nurses

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<td>25046</td>
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**Margaret Warner Graduate School of Education and Human Development**

<table>
<thead>
<tr>
<th>Program Code</th>
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<th>Degree</th>
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<td>25016</td>
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<tr>
<td>25044</td>
<td>1103</td>
<td>Adolescent Education: Foreign Languages (German, Italian, or Chinese)</td>
<td>MS-B</td>
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<tr>
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<tr>
<td>34427</td>
<td>0808</td>
<td>Inclusion Adolescent Education as Generalist</td>
<td>MS</td>
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<td>34424</td>
<td>0808</td>
<td>Teaching SWD in Secondary School as Generalist</td>
<td>MS-B</td>
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<tr>
<td>34425</td>
<td>0808</td>
<td>Teaching Students with Significant Disabilities</td>
<td>MS</td>
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<tr>
<td>25031</td>
<td>0829</td>
<td>Professional Study: Generalist</td>
<td>MS-C</td>
</tr>
<tr>
<td>25030</td>
<td>0804</td>
<td>Middle Childhood Education for Adolescence Education Teachers</td>
<td>MS-C</td>
</tr>
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<td>25033</td>
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<td>Professional Study in Adolescence Education</td>
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Margaret Warner Graduate School of Education and Human Development

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<th>Program Code</th>
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<td>Professional Study: Middle Childhood and Adolescence Education</td>
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Online Teaching and Learning

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<td>Online Teaching and Learning</td>
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Advanced Certification Programs

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<td>Counseling &amp; Human Development</td>
<td>Adv. Cert-C</td>
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<td>25034</td>
<td>0823</td>
<td>Early Childhood Education</td>
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<td>25035</td>
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<td>25041</td>
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<td>Inclusion Childhood Education</td>
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<tr>
<td>25037</td>
<td>1508</td>
<td>Teaching English to Speakers of Other Languages in K–12</td>
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<td>25039</td>
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<td>Reading and Literacies</td>
<td>Adv. Cert-B</td>
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<td>25035</td>
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<td>Adv. Cert-B</td>
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<td>Teaching Students with Significant Disabilities</td>
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<td>37963</td>
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<td>Mental Health to School Counseling</td>
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<td>37814</td>
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<td>Online Teaching</td>
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Graduate Course Numbering System

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<tr>
<th>Course Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>400–489</td>
<td>Master’s first-year-level courses</td>
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<tr>
<td>490–499</td>
<td>Master’s-level reading and research courses</td>
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<tr>
<td>500–599</td>
<td>Advanced or specialized graduate courses and research; usually for doctoral-level students only</td>
</tr>
<tr>
<td>890</td>
<td>Master’s summer registration in residence (not used by Arts, Sciences &amp; Engineering)</td>
</tr>
<tr>
<td>895</td>
<td>Continuation of master’s enrollment</td>
</tr>
<tr>
<td>897</td>
<td>Master’s full-time enrollment status</td>
</tr>
<tr>
<td>898</td>
<td>Master’s part-time enrollment status</td>
</tr>
<tr>
<td>899</td>
<td>Master’s dissertation full-time enrollment</td>
</tr>
<tr>
<td>985</td>
<td>Leaves of absence</td>
</tr>
<tr>
<td>990</td>
<td>Doctoral summer registration in residence (not used by Arts, Sciences &amp; Engineering)</td>
</tr>
<tr>
<td>995</td>
<td>Continuation of doctoral enrollment</td>
</tr>
<tr>
<td>997</td>
<td>Doctoral full-time enrollment status</td>
</tr>
<tr>
<td>998</td>
<td>Doctoral part-time enrollment status</td>
</tr>
<tr>
<td>999</td>
<td>Doctoral dissertation full-time enrollment</td>
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* Leads to more than one degree award
A=Initial teaching certification
B=Initial professional teaching certification
C=Professional teaching certification

Joint Degree Programs

<table>
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<th>Degree</th>
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<tbody>
<tr>
<td>22196</td>
<td>0506</td>
<td>Business Administration</td>
<td>MBA</td>
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</table>
University of Rochester—Credit Hour Policy and Compliance

All University of Rochester degree and certificate programs are approved by the New York State Education Department (NYSED). The University of Rochester’s credit hour calculations for degree and certificate programs follow NYSED guidelines, which are based on the U.S. Department of Education’s definition of credit hour.

The faculty in each school is responsible for all aspects of the curriculum and degree program requirements. Each school has a faculty curriculum committee that reviews proposed new and revised courses and degree programs, including the credit hours associated with each.

See below for further details regarding University of Rochester’s Policies for Credit Hours for Online Teaching and the Simon Business School.

NYSED—Credit Hour Definition

All courses and degree programs at the University must comply with Section 50.1 (o) of the New York State Commissioner of Education Regulations:

Semester hour means a credit, point, or other unit granted for the satisfactory completion of a course which requires at least 15 hours (of 50 minutes each) of instruction and at least 30 hours of supplementary assignments, except as otherwise provided pursuant to section 52.2(c)(4) of this Subchapter. This basic measure shall be adjusted proportionately to translate the value of other academic calendars and formats of study in relation to the credit granted for study during the two semesters that comprise an academic year.


United States Department of Education — Credit Hour Definition

The U.S. Department of Education defines credit hour as: An amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an institutionally established equivalency that reasonably approximates not less than:

1. one hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work for approximately 15 weeks for one semester or trimester hour of credit, or 10 to 12 weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or,

2. at least an equivalent amount of work as required in paragraph (1) of this definition for other academic activities as established by the institution, including laboratory work, internships, practica, studio work, and other academic work leading to the award of credit hours.

Middle States Commission on Higher Education

The Middle States Commission on Higher Education expects all candidate and accredited institutions to demonstrate that they use acceptable and consistent methods for assigning credit hours to all courses and programs of study. The credit hour is defined by the U.S. Department of Education as a basic institutional measure of the level of instruction and academic rigor that establishes eligibility for federal funding.


Online Teaching and Learning Credit Hours

The University of Rochester is committed to making each online course equivalent to its face-to-face counterpart, which includes offering the same minimum level of instructional time and supplemental assignments as required by the New York State Education Department for each credit (i.e., at least 15 hours of 50 minutes each of instruction and at least 30 hours of supplementary assignments). However, in an online course instructional time may take different forms, including but not limited to, a combination of online synchronous sessions, recorded lectures and narrated PowerPoint presentations, instructor-facilitated asynchronous discussion boards, instructor-facilitated long-term projects, and one-on-one video chat communications with the instructors.

Simon Business School’s Policy for Credit Hours for Graduate Study

Semester credit hours for Simon graduate-level courses are used even though the school follows a calendar based on quarters. This maintains compatibility with the rest of the campus that is on semesters.

The typical course offered during the workday for full-time students bears three credit hours, requiring 27 hours of in-class contact time over the term and 85.5 hours of time outside the class, for a total of 112.5 hours for three credit hours. (See calculations below based on NYSED-defined 50-minute class periods.)

Four of the courses for the MBA students have a one-credit-hour lab attached that meets for 50 minutes, once per week. Each hour of lab requires four hours outside the classroom.

The evening courses, executive courses, and the courses offered at the NYC location for professional have an in-class time of 2.4 hours. These courses are taught with an expectation of slightly higher out-of-class hours to bring the total to over 100 total hours for the three-credit-hour course.
As is common with business school/professional programs, each hour of in-class time requires between 3.16 and 4.0 hours of work outside the classroom in the form of individual study, team work, library/online research, and visits to and with business executives.

**Credit Hour Calculations**

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<tr>
<th>Class Type</th>
<th>Semester Credit Hours</th>
<th>In class actual hours/term</th>
<th>Out of class expected hours/term</th>
<th>Total Hours</th>
<th>Effective Total Hours @ 50 minutes/hour</th>
<th>Effective hours/credit</th>
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</thead>
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<td>Day</td>
<td>3</td>
<td>27</td>
<td>85.5</td>
<td>112.5</td>
<td>135</td>
<td>45</td>
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<td>112.5</td>
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<td>45</td>
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<tr>
<td>Exec and Professional</td>
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<td>24</td>
<td>88.5</td>
<td>112.5</td>
<td>135</td>
<td>45</td>
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</table>
Committee on Graduate Studies

The Committee on Graduate Studies shall consist of the following members: the Arts, Sciences & Engineering Dean of Graduate Studies, the Director of Graduate Studies for each program that offers a PhD or master’s degree.

A faculty representative shall serve for as long as she or he is the program’s Director of Graduate Studies. When a program selects a new Director of Graduate Studies, this member will join the Committee on Graduate Studies. To obtain a list of the current members of the Committee on Graduate Studies, please contact the Graduate Studies Office.

Special Requirements for Arts, Sciences & Engineering

Admission Regulations

Applicants for admission to graduate work must demonstrate to the dean of graduate studies as well as the department of their major interest that their training and ability are such as to ensure reasonable chances of success in work towards advanced degrees. All applicants for admission must present evidence that, exclusive of introductory courses, they have completed no less than 18 credit hours of college work of high standing in their principal subject of study, or a satisfactory equivalent. Students with satisfactory undergraduate records that do not include 18 hours of credit in the field of their choice may be admitted and required to complete prerequisites prescribed by the department. Preparation in related subjects must be satisfactory, and applicants may be required to have knowledge of the skills essential to their fields of study. Undergraduate programs should provide evidence that students have taken relevant introductory work in the humanities, social sciences, sciences, or engineering.

To be assured credit for graduate work, admission to graduate studies should precede any work done at the University of Rochester that is to be applied toward the master’s or PhD degree.
Degree Requirements
University regulations that apply to the Master of Arts, Master of Science, and Doctor of Philosophy degrees are enumerated earlier in this bulletin under the heading Graduate Degrees. Additional requirements for Arts, Sciences & Engineering graduate students are listed here and in the individual departments’ sections.

PhD Degree Requirements
The degree Doctor of Philosophy requires the equivalent of 90 hours of work beyond the bachelor’s degree and at least one academic year of full-time study in residence. The program of study for the degree Doctor of Philosophy must be submitted for the approval of the dean of graduate studies within two years of matriculation.

All PhD students in Arts, Sciences & Engineering must take the qualifying examination either before starting their seventh semester of study or before the fourth calendar year, whichever is longer. In exceptional circumstances, and with the prior approval of the dean of graduate studies, these limits may be extended. A department may require the student to take the qualifying examination before the stated time limits. Six months must elapse between the qualifying examination and the final oral examination (thesis defense).

By action of the Committee on Graduate Studies, the following departmental PhD qualifying examination committees are not required to include a member from outside the department: Biology, Brain and Cognitive Sciences, Chemistry, Clinical and Social Sciences in Psychology, Earth and Environmental Sciences, Economics, Mathematics, Philosophy, Physics and Astronomy, and Political Science.

Master of Arts and Master of Science Degree Requirements
The degrees Master of Arts and Master of Science under Plan A are awarded for successful completion of at least 30 credit hours of graduate-level work, where graduate-level work is defined as courses that are advanced in content, rigor, and requirements. Of these 30 credit hours, at least 6 and normally no more than 12 hours must be in research/reading courses, and at least 18 hours must be in formal coursework. The student must also successfully defend a written thesis.

The degrees Master of Arts and Master of Science under Plan B are awarded for successful completion of at least 30 credit hours of graduate-level work, where graduate-level work is defined as courses that are advanced in content, rigor, and requirements, and satisfactory performance on an oral, written, or essay comprehensive examination in the student’s field of specialization. The qualifying examination for the PhD degree may be substituted. Of the required 30 credit hours, at least 18 of these hours must be in the student’s principal department or program. If the department requires a master’s essay, this course may carry up to 4 hours of credit. Total credit for research, reading, and the master’s essay cannot exceed 6 hours.

The program of study for the degree Master of Arts or the degree Master of Science must be submitted for the approval of the dean of graduate studies within two semesters of matriculation. Part-time master’s candidates must file a proposed program of study upon the completion of 12 hours of graduate credit.

Master of Arts and Master of Science degrees in interdepartmental studies within fields of study in Arts, Sciences & Engineering that have viable master’s degree-granting programs allow students to combine work in fields of study that have been considered separate or merely allied to develop degree programs that meet new and specialized interests. The procedures for planning and approval of an interdepartmental master’s degree program are handled through the Arts, Sciences & Engineering Graduate Studies Office (GSO) in Lattimore Hall. Once students have a general idea of their areas of interest, they need to review the course offerings in the degree-granting departments with which they will develop the interdepartmental degree. Initial inquiries should be directed to the Graduate Studies Office in 218 Lattimore Hall. Students must apply to and be accepted into the degree-granting departments with which they will develop the interdepartmental degree.

Grading
A student who receives the grade of C or E in one or more courses will be considered to have an unsatisfactory record and will be automatically placed on Arts, Sciences & Engineering academic probation. A student on academic probation may not be awarded a graduate degree. To be removed from academic probation, the student must complete 12 semester hours of graduate credit with no grade lower than B–. If the student receives any grade lower than B–, the student is subject to removal from the program. In special cases, this may be reviewed by the dean of graduate studies.

Students receiving C grades in courses in excess of 20 percent of their complete programs are considered to have unsatisfactory records; they cannot graduate until their programs of study have been adjusted to eliminate the excess. In special cases, this may be reviewed by the dean of graduate studies.

The grade of I (Incomplete) is an option providing a student with additional time to complete unfinished work. The unfinished work should be completed no later than one calendar year (two semesters) after the end of the semester in which the original course was taken. If the work is completed within one calendar year, the official transcript will show only the final grade. If the work is completed after one calendar year, the official transcript will show an I and the final grade.

Repeating a Course
In general, a course may not be repeated for credit once it is taken for credit or audit. Exceptional situations requiring the student to repeat a course for credit can be petitioned to the dean of graduate studies.
School of Arts & Sciences

Administrative Officers

Gloria M. Culver, PhD  
Dean

Melissa Sturge-Apple, PhD  
Dean of Graduate Studies for Arts, Sciences & Engineering

Faculty

George Alessandria, PhD (Pennsylvania)  
Professor of Economics

Janet Berlo, PhD (Yale)  
Professor of Art History and of Visual and Cultural Studies

Xin Bi, PhD (Johns Hopkins)  
Professor of Biology

Nicholas P. Bigelow, PhD (Cornell)  
Lee A. DuBridge Professor of Physics

Mark Bils, PhD (MIT)  
Hazelt Pye Professor of Economics

Eric Blackman, PhD (Harvard)  
Professor of Physics and Astronomy

David Bleich, PhD (New York University)  
Professor of English

Arie Bodek, PhD (MIT)  
George E. Pake Professor of Physics

Robert K. Boeckman, Jr., PhD (Brandeis)  
Marshall D. Gates, Jr. Professor of Chemistry

Daniel Borus, PhD (Virginia)  
Professor of History

Kara Bren, PhD (California Institute of Technology)  
Professor of Chemistry

Douglas R. Brooks, PhD (Harvard)  
Professor of Religion

Theodore Brown, PhD (Princeton)  
Charles E. and Dale L. Phelps Professor in Public Health and Policy and Professor of History

Gregory N. Carlson, PhD (Massachusetts, Amherst)  
Professor of Linguistics

Yongsung Chang, PhD (Rochester)  
Professor of Economics

Frederick R. Cohen, PhD (Chicago)  
Professor of Mathematics

Earl Conee, PhD (Massachusetts, Boston)  
Professor of Philosophy

John Covach, PhD (Michigan)  
Professor of Music

Douglas Crimp, PhD (CUNY)  
Fanny Knapp Allen Professor in Fine Arts and Professor of Art History and of Visual and Cultural Studies

Gloria M. Culver, PhD (Rochester)  
Professor of Biology

Randall Curren, PhD (Pittsburgh)  
Professor of Philosophy

Ashok Das, PhD (SUNY, Stony Brook)  
Professor of Physics

Patrick Davies, PhD (West Virginia)  
Professor of Psychology

Gregory DeAngelis, PhD (California, Berkeley)  
George Eastman Professor and Professor of Brain and Cognitive Sciences

Regina Demina, PhD (Northeastern)  
Professor of Physics

Joseph P. Dinnocenzo, PhD (Cornell)  
Professor of Chemistry

Robert Doran, PhD (Stanford)  
Professor of French

John Duggan, PhD (California Institute of Technology)  
Professor of Political Science

Paul Duro, PhD (Essex)  
Professor of Art History and of Visual and Cultural Studies

Morris Eaves, PhD (Tulane)  
Richard L. Turner Professor of English

Joseph Eberly, PhD (Stanford)  
Andrew Carnegie Professor of Physics
Thomas Eickbush, PhD (Johns Hopkins)
  Professor of Biology
Andrew Elliot, PhD (Wisconsin)
  Professor of Psychology
James M. Farrar, PhD (Chicago)
  Professor of Chemistry
Richard Feldman, PhD (Massachusetts, Boston)
  Professor of Philosophy
Mark Fey, PhD (California Institute of Technology)
  Professor of Political Science
William FitzPatrick, PhD (California, Los Angeles)
  Gideon Webster Burbank Professor of Intellectual and Moral Philosophy
Robert Foster, PhD (Chicago)
  Richard L. Turner Professor of Anthropology and of Visual and Cultural Studies
Adam Frank, PhD (Washington, Seattle)
  Professor of Physics and Astronomy
Alison Frontier, PhD (Columbia)
  Professor of Chemistry
Michael Gage, PhD (Stanford)
  Professor of Mathematics
Gerald Gamm, PhD (Stanford)
  Professor of Political Science
Yongli Gao, PhD (Harvard)
  Professor of Physics
Carmala N. Garzone, PhD (Arizona)
  Helen and Fred H. Goen Professor of Earth and Environmental Sciences
Dan-Andrei Geba, PhD (Princeton)
  Professor of Mathematics
Thomas Gibson, PhD (London)
  Professor of Anthropology
David A. Goldfarb, PhD (California, Davis)
  Professor of Biology
Steven M. Gonek, PhD (Michigan)
  Mercer Brugler Distinguished Teaching Professor and Professor of Mathematics
Joshua Goodman, PhD (Yale)
  Professor of Chemistry
Vera Gorbunova, PhD (Weissman Institute of Science, Israel)
  Doris Johns Cherry Professor of Biology
Srihari Govindan, PhD (SUNY, Stony Brook)
  Professor of Economics
Allan Greenleaf, PhD (Princeton)
  Professor of Mathematics
Kenneth Gross, PhD (Yale)
  Alan F. Hilfiker Distinguished Professor in English
Jennifer Grotz, PhD (Houston)
  Professor of English
Susan Gustafson, PhD (Stanford)
  Karl F. and Bertha A. Fuchs Professor of German Studies
Carl R. Hagen, PhD (MIT)
  Professor of Physics
Thomas G. Hahn, PhD (California, Los Angeles)
  Professor of English
Gretchen Helmké, PhD (Chicago)
  Professor of Political Science
Sarah Higley, PhD (California, Berkeley)
  Professor of English
Th. Emil Homerin, PhD (Chicago)
  Professor of Religion
Aaron Hughes, PhD (Indiana, Bloomington)
  Philip S. Bernstein Professor of Judaic Studies and Professor of Religion
Joseph E. Inikori, PhD (University of Ibadan, Nigeria)
  Professor of History
Alex Iosevich, PhD (California, Los Angeles)
  Professor of Mathematics
Robert Jacobs, PhD (Massachusetts, Boston)
  Professor of Brain and Cognitive Sciences
T. Florian Jaeger, PhD (Stanford)
  Professor of Brain and Cognitive Sciences
John Jaenike, PhD (Princeton)
  Professor of Biology
James Johnson, PhD (Chicago)
  Professor of Political Science
William D. Jones II, PhD (California Institute of Technology)
  Charles Frederick Houghton Professor of Chemistry
Andrew Jordan, PhD (California, Santa Barbara)
  Professor of Physics
Beth Jörgensen, PhD (Wisconsin)
  Professor of Spanish
Richard W. Kaeuper, PhD (Princeton)
  Professor of History
Cilas Kemedjio, PhD (Ohio State)
  Frederick Douglass Professor of Modern Languages and Cultures
Narayana Kocherlakota, PhD (Chicago)
  Lionel W. McKenzie Professor of Economics
Kim H. Kowalke, PhD (Yale)
  Professor of Music
Todd D. Krauss, PhD (Cornell)
  Professor of Chemistry
Thomas R. Krugh, PhD (Pennsylvania State)
  Professor of Chemistry
Bette London, PhD (California, Berkeley)
  Professor of English
James Longenbach, PhD (Princeton)
  Joseph Henry Gilmore Professor of English
Saul Lubkin, PhD (Harvard)
  Professor of Mathematics
Elias Mandala, PhD (Minnesota)
  Professor of History
Steven Manly, PhD (Columbia)
  Professor of Physics
Joyce McDonough, PhD (Massachusetts, Boston)
  Professor of Linguistics
Kevin McFarland, PhD (Chicago)
  Professor of Physics
Honey Meconi, PhD (Harvard)
  Professor of Music
John Michael, PhD (Johns Hopkins)
  Professor of English and of Visual and Cultural Studies
Gautam Mitra, PhD (Johns Hopkins)
  Professor of Geology
Deborah Modrak, PhD (Chicago)
  Professor of Philosophy
Govind S. Mudholkar, PhD (North Carolina, Chapel Hill)
  Professor of Statistics
Carl Mueller, PhD (California, Berkeley)
Professor of Mathematics

Kathy W. Nordeen, PhD (California, Irvine)
Professor of Brain and Cognitive Sciences

H. Allen Orr, PhD (Chicago)
Shirley Cox Kearns Professor of Biology

Lynne H. Orr, PhD (Chicago)
C. E. Kenneth Mees Professor of Physics

Dorinda Outram, PhD (Cambridge)
Franklin W. and Gladys I. Clark Professor of History

Jonathan Pakianathan, PhD (Princeton)
Professor of Mathematics

S. R. S. Rao Poduri, PhD (Harvard)
Professor of Statistics

Robert Poreda, PhD (California, San Diego)
Professor of Geology

G. Bingham Powell, PhD (Stanford)
Marie Curran Wilson and Joseph Chamberlain Wilson Professor of Political Science

Lynda W. Powell, PhD (Rochester)
Professor of Political Science

Daven Presgraves, PhD (Rochester)
University Dean's Professor of History and Professor of Biology

Alice Quillen, PhD (California Institute of Technology)
Professor of Physics and Astronomy

Sarada G. Rajeev, PhD (Syracuse)
Professor of Physics

Douglas Ravenel, PhD (Brandeis)
Daniel Burton Fayerweather Professor of Mathematics

Harry T. Reis, PhD (NYU)
Professor of Psychology

Juan Rivera-Letelier, PhD (Paris Sud)
Professor of Mathematics

Lewis Rothberg, PhD (Harvard)
Professor of Chemistry

Lawrence Rothenberg, PhD (Stanford)
Corrigan-Minehan Professor in Political Science

Joan Shelley Rubin, PhD (Yale)
Dexter Perkins Professor in History

Michele Rucci, PhD (Sant’Anna School of Advanced Studies, Italy)
Professor of Brain and Cognitive Sciences

Jeffrey Runner, PhD (Massachusetts, Amherst)
Professor of Linguistics

Sema Salur, PhD (Michigan State)
Professor of Mathematics

Claudia Schaefer, PhD (Washington, Saint Louis)
Rush Rhees Professor and Professor of Spanish

Wolf-Udo Schröder, PhD (Darmstadt)
Professor of Chemistry

Joanna Scott, MA (Brown)
Russell Smith Burrows Professor of English

Andrei Seluanov, PhD (Weizmann Institute of Science, Israel)
Professor of Biology

Yonathan Shapir, PhD (Tel Aviv)
Professor of Physics

Elaine Sia, PhD (Columbia)
Professor of Biology

Thomas Slaughter, PhD (Princeton)
Arthur R. Miller Professor of History

Judith G. Smetana, PhD (California, Santa Cruz)
Professor of Psychology

Thomas Spence Smith, PhD (Chicago)
Professor of Sociology

Laura Smoller, PhD (Harvard)
Professor of History

Randall Stone, PhD (Harvard)
Professor of Political Science

Michael K. Tänenhaus, PhD (Columbia)
Beverly Peterson Bishop & Charles W. Bishop Professor of Brain and Cognitive Sciences

John Tarduno, PhD (Stanford)
Professor of Geophysics

Stephen Teitel, PhD (Cornell)
Professor of Physics

Dinesh Thakur, PhD (Harvard)
Professor of Mathematics

William Thomson, PhD (Stanford)
Elmer B. Milliman Distinguished Professor of Economics

Sheree Toth, PhD (Case Western Reserve)
Professor of Psychology

Thomas Tucker, PhD (California, Berkeley)
Professor of Mathematics

Dan Watson, PhD (California, Berkeley)
Professor of Physics and Astronomy

Stewart Weaver, PhD (Stanford)
Professor of History

Michael Welte, PhD (Chicago)
Professor of Biology

John Werren, PhD (Utah)
Nathaniel and Helen Wisch Professor in Biology

Robert Westbrook, PhD (Stanford)
Joseph F. Cunningham Professor of History

Sharon Willis, PhD (Cornell)
Professor of Art History and of Visual and Cultural Studies

Frank Wolfs, PhD (Chicago)
Professor of Physics

Miron Zuckerman, PhD (Harvard)
Professor of Psychology

Paul Audi, PhD (Princeton)
Associate Professor of Philosophy

Yan Bai, PhD (Minnesota)
Associate Professor of Economics

Matthew BaileyShea, PhD (Yale)
Associate Professor of Music

Paulo Barelli, PhD (Columbia)
Associate Professor of Economics

Daniel Beaumont, PhD (Princeton)
Associate Professor of Arabic Language and Literature

Loisa Bennett, PhD (Denver)
Associate Professor of Psychology

Cheeptip Benyajati, PhD (Princeton)
Associate Professor of Biology
Joanne Bernardi, PhD (Columbia)  
Associate Professor of Japanese

Curt Cadorette, PhD (St. Michael’s College, Toronto)  
John Henry Neuman Professor of Roman Catholic Studies and Associate Professor of Religion

Jessica Cantlon, PhD (Duke)  
Associate Professor of Brain and Cognitive Sciences

Shin-Yi Chao, PhD (British Columbia)  
Associate Professor of Religion

Bin Chen, PhD (Cornell)  
Associate Professor of Economics

Kevin Clarke, PhD (Michigan)  
Associate Professor of Political Science

Elizabeth Colantoni, PhD (Michigan)  
Associate Professor of Classics

Jennifer Creech, PhD (Minnesota)  
Associate Professor of German

Thomas Devaney, PhD (Minnesota)  
Associate Professor of History

Rudi Fasan, PhD (Brown)  
Associate Professor of History

Justin Fay, PhD (Chicago)  
Associate Professor of Biology

Signithia Fordham, PhD (American University)  
Associate Professor of Anthropology

James Fry, PhD (Michigan)  
Associate Professor of Anthropology

Aran Garcia-Bellido, PhD (Royal Holloway, London)  
Associate Professor of Physics

John Givens, PhD (Washington, Seattle)  
Associate Professor of Russian

Hein Goemans, PhD (Chicago)  
Associate Professor of Political Science

C. Douglas Haessig, PhD (California, Irvine)  
Associate Professor of Mathematics

Rachel Haidu, PhD (Columbia)  
Associate Professor of Art History and of Visual and Cultural Studies

Benjamin Hayden, PhD (California, Berkeley)  
Associate Professor of Brain and Cognitive Sciences

Gregory Heyworth, PhD (Princeton)  
Associate Professor of English

Larry E. Hudson, PhD (Keele)  
Associate Professor of History

June Hwang, PhD (California, Berkeley)  
Associate Professor of German

Jeremy Jamieson, PhD (Northeastern)  
Associate Professor of Psychology

Michael Jarvis, PhD (William and Mary)  
Associate Professor of History

Naomi Jochnowitz, PhD (Harvard)  
Associate Professor of Mathematics

Anastasios Kalandrakis, PhD (California, Los Angeles)  
Associate Professor of Political Science

Rosemary Kegl, PhD (Cornell)  
Associate Professor of English

John Kessler, PhD (California, Irvine)  
Associate Professor of Earth and Environmental Sciences

Asen Kochov, PhD (Rochester)  
Associate Professor of Economics

Jennifer Kyker, PhD (Pennsylvania)  
Associate Professor of Music

David Lambert, PhD (Arizona)  
Associate Professor of Biology

Matthew Lenoe, PhD (Chicago)  
Associate Professor of History

Bradford Mahon, PhD (Harvard)  
Associate Professor of Brain and Cognitive Sciences

Katherine Mannheimer, PhD (Yale)  
Associate Professor of English

David McCamant, PhD (California, Berkeley)  
Associate Professor of Chemistry

Bonnie Meguid, PhD (Harvard)  
Associate Professor of Political Science

Jason Middleton, PhD (Duke)  
Associate Professor of English and of Visual and Cultural Studies

Michael Neidig, PhD (Stanford)  
Associate Professor of Chemistry

Bradley Nilsson, PhD (Wisconsin)  
Associate Professor of Chemistry

John Osburg, PhD (Chicago)  
Associate Professor of Anthropology

Ronni Pavan, PhD (Chicago)  
Associate Professor of Economics

Cary Peppermint, MFA (Syracuse)  
Associate Professor of Art History

Vasili Petrenko, PhD (California, San Diego)  
Associate Professor of Earth and Environmental Sciences

Ryan Prendergast, PhD (Emory)  
Associate Professor of Spanish

David Primo, PhD (Stanford)  
Ani and Mark Gabrellian Professor and Associate Professor of Political Science

Supriitha Rajan, PhD (North Carolina, Chapel Hill)  
Associate Professor of English

Daniel Reichman, PhD (Cornell)  
Associate Professor of Anthropology

Raúl Rodríguez-Hernández, PhD (Cornell)  
Associate Professor of Spanish

Ronald Rogge, PhD (California, Los Angeles)  
Associate Professor of Psychology

Nora Rubel, PhD (North Carolina, Chapel Hill)  
Jane and Alan Batkin Endowed Professor in Jewish Studies and Associate Professor of Religion

Joan Saab, PhD (New York University)  
Susan B. Anthony Professor and Associate Professor of Art History and of Visual and Cultural Studies

Stephen Schottenfeld, MFA (Iowa)  
Associate Professor of English

Curtis Signorino, PhD (Harvard)  
Associate Professor of Political Science

Donatella Stocchi-Perucchio, PhD (Cornell)  
Associate Professor of Italian

Melissa Sturge-Apple, PhD (Notre Dame)  
Associate Professor of Psychology

Duje Tadin, PhD (Vanderbilt)  
Associate Professor of Brain and Cognitive Sciences
Ezra Tawil, PhD (Brown)  
Associate Professor of English

Allen Topolski, MFA (Pennsylvania State)  
Associate Professor of Art

Jeffrey Tucker, PhD (Princeton)  
Associate Professor of English

Daniel Weix, PhD (California, Berkeley)  
Associate Professor of Chemistry

Nese Yildiz, PhD (Stanford)  
Associate Professor of Economics

Scott Abramson, PhD (Princeton)  
Assistant Professor of Political Science

Yu Awaya, PhD (Pennsylvania State)  
Assistant Professor of Economics

Segev BenZvi, PhD (Columbia)  
Assistant Professor of Physics and Astronomy

Daniel Bergstrahl, PhD (North Carolina, Chapel Hill)  
Assistant Professor of Biology

William Bridges, PhD (Princeton)  
Assistant Professor of Japanese

Jennifer Brisson, PhD (Washington, Saint Louis)  
Assistant Professor of Biology

Joel Burges, PhD (Stanford)  
Assistant Professor of English

Carolina Caetano, PhD (California, Berkeley)  
Assistant Professor of Economics  
Assistant Professor of Art History

Gregorio Caetano, PhD (California, Berkeley)  
Assistant Professor of Economics

Andrew Aaron Cashner, PhD (Chicago)  
Assistant Professor of Music

Xuwen Chen, PhD (Maryland)  
Assistant Professor of Mathematics

Peter Christensen, PhD (Harvard)  
Assistant Professor of Art History

Hayley Clatterbuck, PhD (Wisconsin)  
Assistant Professor of Philosophy

Kristin Doughtry, PhD (Pennsylvania)  
Assistant Professor of Anthropology

Joshua Dubler, PhD (Princeton)  
Assistant Professor of Religion and Classics

Laura Elenbaas, PhD (Maryland, College Park)  
Assistant Professor of Psychology

John Stephen Feldman, PhD (New York University)  
Assistant Professor of History

Ignacio Franco, PhD (Toronto)  
Assistant Professor of Chemistry

Anderson Frey, PhD (British Columbia)  
Assistant Professor of Political Science

Dragony Fu, PhD (California, Berkeley)  
Assistant Professor of Biology

Sina Ghaemmaghami, PhD (Duke)  
Assistant Professor of Biology

Gourab Ghoshal, PhD (Michigan)  
Assistant Professor of Physics

Catherine Glenn, PhD (SUNY, Stony Brook)  
Assistant Professor of Psychology

Pierre Gourdain, PhD (California, Los Angeles)  
Assistant Professor of Physics

Scott Grimm, PhD (Stanford)  
Assistant Professor of Linguistics

Margarita Guillory, PhD (Rice)  
James Peter Wilmot Distinguished Assistant Professor of Religion and Classics

Ralf Haefner, PhD (Oxford)  
Assistant Professor of Brain and Cognitive Sciences

Cameron Hawkins, PhD (Chicago)  
Assistant Professor of Religion and Classics

Dahpon Ho, PhD (California, San Diego)  
Assistant Professor of History

David Holloway, PhD (Washington, Saint Louis)  
Assistant Professor of Japanese  
Assistant Professor of Mathematics

Mauricio Ibanez-Mejia, PhD (Arizona)  
Assistant Professor of Earth and Environmental Sciences

Emily Jusino, PhD (Chicago)  
Assistant Professor of Religion and Classics

Celeste Kidd, PhD (Rochester)  
Assistant Professor of Brain and Cognitive Sciences

Stephen Kleene, PhD (Johns Hopkins)  
Assistant Professor of Mathematics

Kathryn Knowles, PhD (Northwestern)  
Assistant Professor of Chemistry

Arjun Krishnan, PhD (New York University)  
Assistant Professor of Mathematics

Mary Kroeger, PhD (Princeton)  
Assistant Professor of Political Science

Chigusa Kurumada, PhD (Stanford)  
Assistant Professor of Brain and Cognitive Sciences

Bethany A. Lacina, PhD (Stanford)  
Assistant Professor of Political Science

Amanda Larracuente, PhD (Cornell)  
Asaro Biggar Family Professor in Data Science and Assistant Professor of Biology

Evelync Leblanc-Roberge, MFA (Alfred)  
Assistant Professor of Art

Alexander Lee, PhD (Stanford)  
Assistant Professor of Political Science

Lihong Liu, PhD (New York University)  
Assistant Professor of Art History

Dan Lu, PhD (Chicago)  
Assistant Professor of Economics

Kathryn Mariner, PhD (Chicago)  
Assistant Professor of Anthropology

Ellen Hicks Matson, PhD (Purdue)  
Assistant Professor of Chemistry

William Miller, PhD (Johns Hopkins)  
Assistant Professor of English

Jude Mitchell, PhD (California, San Diego)  
Assistant Professor of Biology

Sevak Mkrtchyan, PhD (California, Berkeley)  
Assistant Professor of Mathematics

Sergio Montero Fortes, PhD (California Institute of Technology)  
Assistant Professor of Political Science

Lee Murray, PhD (Harvard)  
Assistant Professor of Earth and Environmental Sciences
African & African-American Studies

429. Narratives of Slavery
430. African-American Autobiography
435. Ethnic Politics
443. Major Authors: toni Morrison
444. Black Intellectuals
449. The Civil War
450. Race in American Fiction
456. His of Race in America
462. Africa Diaspora in Latin
472. Harlem Renaissance
890. Summer in Residence - MA
986V. Full Time Visiting Student
990. Summer in Residence
997. Doctoral Dissertation

American Sign Language

987V. Part Time Visiting Student
Anthropology

416. Medical Anthropology

422. Materiality and Meaning

457. Chinese Society After Mao

464. Islam and Global Politics

466. Anthropology of Globalization

468. Science, Culture & Expertise

In this course, we will investigate how people develop knowledge about the natural and social worlds. Through these case studies, we will explore the ways in which personal relations, cultural values, and power struggles are essential to scientific production rather than peripheral to it.

470. Radical Social Theory


This colloquium will facilitate research into the life, works and legacies of Lewis Henry Morgan (1818-1881).

491. Master’s Readings in Anthro

495. Master’s Research in Anthro

499. Malawi Immersion Seminar

A three week study abroad/experiential learning program focusing on the health, social, political and cultural issues in Malawi, Africa. (Summer)

506. Adv Top Sem: the Corporation

This seminar considers the prospects for an anthropology of corporations that focuses on the specific historical, legal, and structural features of the modern for-profit, investor-owned business corporation.

591. PhD Readings in Anthropology

595. PhD Research in Anthropology

986V. Full Time Visiting Student

990. Summer in Residence

Art & Art History

ART HISTORY

402. Chinese Film

403. Digital Cityscapes

408. Early Modern Chinese Painting

411. French Cinema: the New Wave

This course will explore the American landscape as a cultural artifact with historically specific meanings in particular contexts over time. It will focus heavily on landscape art of the United States, from its English roots, to the Hudson River School and Luminism, to art of the American West. Additional topics of study will include landscape tourism, mapping, built environments, national parks, the preservationist impulse, and the role of the landscape in Euro-American and Native American literature. Placing primary interpretive texts against more recent methodologies, this course will locate the nationalistic, social and cultural dimensions of the American landscape, while also scrutinizing iconic and contextual meanings in works of landscape art.

412. What Photo Is

413. Race & Gender in Pop Film

This course explores Hollywood’s fascination with race and gender as social issues and as spectacles. In particular, we will focus on the ways that social difference have become the sites of conflicted narrative and visual interactions in our films. To examine competing representations of racial difference and sexual difference in US culture, we analyze popular films from the 1950’s to the present.

415. Sem in Cont Art: Perf

Spring 2010. Please see AH 215 for description.

416. Orientalism Art & Arch

417. Frameworks Space and Place

418. Photography in East Asia

419. 21st Century Art Museum

420. Paris: capital of the 19th C

422. Photographic Processes

This course is restricted to PPCM students only.

This course acts as an introduction to photographic preservation through the investigation of historic photographic materials.
423. Collections Mngt & Care
This course is restricted to PPCM students only.
This course provides an overview of collection registration and cataloguing.

424. History of Photography II
This history of photography through the careful study of photographic objects from the collection at GEH. We will investigate the ways in which technological change influences the practice of image making, and the way the needs and dreams of artists, scientists and ordinary citizens inspired new uses of cameras and photographic materials. We will seek to understand the historical, cultural and artistic context within which photographic images were first seen and used, and also to understand how meanings and uses of those images change over time. In addition to seminar participation, students will conduct original research about a photograph, photographer, or body of work using methods we develop over the semester to produce a paper that illuminates their chosen subject, showing how it fits within a larger history of photography, and within the history of the time and place from which it has come.

425. Catalog & Research Methods
The cataloging portion of the class is designed to familiarize students with the basic principles behind descriptive and subject cataloging. The research methods component is dedicated to teaching the methodologies that will allow students to undertake scholarly projects focused on the history of photography. By the end of this course, students will demonstrate proficiency with providing accurate and discoverable information about photographic objects as well as the primary research required to write an academic research paper about photographs.

430. History of Photography

433. Thinking Through the Copy

434. Art and Environment

435. Medium & Materiality in Chi

436. History of French Cinema
This course examines Christian art in its cultural context in Eastern Europe, the Near East, and the Slavic world. The main theme will be the art of the Byzantine Empire centered in Constantinople until 1453, but in addition, we will look at developments in Post Byzantine Greece, the Balkans, Bulgaria, Kievan Rus', Armenia, and Georgia.

437. Islamic Arch in Context

438. Black Lit & Visual Culture

440. Andy Warhol: Topics in Cont
As the most famous artist of the second half of the twentieth century, Warhol has been the subject of a growing literature that expands upon art history and criticism to encompass queer theory and cultural studies. But the most important shift in Warhol's reception has been brought about by the restoration and return to circulation of his prolific film output from the years 1963-69. The films will be the main focus of this course, but we will also consider Warhol's early work as a fashion illustrator, his entrepreneurship at the Factory, his voracious collecting, and, of course, his paintings. We will read Warhol's writings, including *A Novel*. The Philosophy of Andy Warhol, and *Popism*; and we will examine new approaches to Warhol and ask how they illuminate not only the art but also such issues as consumption, publicity, visibility, celebrity, sexuality, identity, and selfhood.

441. Aesthetics

442. Hist of Photo: 1839-1915

443. Foucault & Ethics

448. French Philosophy Since 1960

450. Age of Baroque
Spring 2010. Please see AH 250 for description.

453. Film History: 1929-1959

454. Film History: 1959-1989
This course will explore developments in world cinema—industrial, social, and political—from 1959 to 1989. It will explore film aesthetics, technologies, and circulation questions, considering questions like the following: What's new about the French New Wave? What do we mean by Third Cinema? How do different national cinemas influence each other? In what ways have various national cinemas responded critically to Hollywood's commercial dominance and to its conventions? How do popular and "art" cinemas speak to each other. How does cinema respond to the pressures and provocations of other media at the inception of the digital age? Weekly screenings and film journals required. FMS 132, “Introduction to the Art of Film,” typically a prerequisite.

455. Arts in American Culture
What did it mean to be American? What did America look like, geographically and in terms of its people? What part did art and photography play in documenting and giving an identity to Americans in the century between 1850 and 1950? Attention will be given to documenting and representing the West, immigration, and the emerging urban environment. Students will work with the collections of George Eastman House and the Memorial Art Gallery. Requirements for the course include a short museum paper, a term paper, with draft, and take-home midterm and final exams.
459. Women, Cloth & Culture
460. Masters Seminar
462. Impress & Post Impress
Spring 2010. Please see AH 262 for description.
464. Films of the 1930s
465. Photo in Sp & Sp America
466. African-American Vis Culture
469. The Art Market
470. Contemporary Chinese Art
474. Culture His of Amer Arch
481. Art & City: ny in the 70’s
The recession & fiscal crisis of the 1970s was paradoxically a highly productive period of artistic experimentation in New York City. In the wake of the transforming art movements of the 1960s--Pop, Minimalism, and Conceptual Art--the 1970s saw the invention of new and hybrid media: video art, performance art, & site-specific installation works. By the end of the decade a new group of artists that came to be known as the Pictures Generation began showing in alternative spaces such as Artists Space. In this seminar we will study how the de-industrialization of New York contributed to new kinds of art making & examine how art works take the city as their subject. Among the artists we will consider are Bernd & Hilla Becher, Gordon Matta-Clark, Joan Jonas, Peter Hujar, Danny Lyon, Cindy Sherman, and Thomas Struth. Avant-garde film also took the city as its subject; the course will include the work such film & video-makers as Dara Birnbaum, Ernie Gehr, Peter Hutton, Babette Mangolte, and Charles Simmonds.
482. Ren. Art: space Narrtv, Form
483. Contemporary French Film
Through close analysis of popular film, this course explores contemporary French culture as it reworks national identity. Focusing on changing definitions of “Frenchness” the course examines its articulations with shifting conceptions of tradition, of the popular, and of the nation. Readings include central cultural conflicts around identity and difference in the context of the emergent European economic community, as well as the specifically French context of “immigration” and “assimilation.” Of particular interest is the comparative analysis of French and U.S. popular discourses on social issues involving sexuality and gender, race, ethnicity, and “multiculturalism.” Films include works by Bertrand Blier, Luc Bresson, Andre Techine, Cyril Collard [SAVAGE NIGHTS], Mathieu Kassovitz, Claire Denis, Francois, Ahmed Bouchalla [KRIM], Karim Dridi [Bye-Bye] as well as recent works by such widely known auteurs as Claude Chabrol and Jean-Luc Godard.

484. Modern Arch & Urbanism
Prerequisite: Introduction to VCS or Introduction to Art History
The architecture of Los Angeles will serve two different purposes in this seminar. On the one hand, we will study the whole range of modern architecture--from mission style (Gill), arts and crafts (Greene and Greene), and the early modernists (Wright, Schindler), to high modernism (Neutra, the Case Study houses), and postmodernism (Gehry)--as a singular regional, but nevertheless representative development of modern architecture. On the other hand, using architecture as a starting point, we will look at the strange utopia/dystopia of Los Angeles as an example of a new kind of urbanism and style of living. Our texts will include not only studies of architecture, but also Hollywood films (Chinatown, Bladerunner), detective novels (Raymond Chandler), new journalism (Joan Didion), and urban theory (Reyner Banham, Mike Davis).

485. History of Photography II
487. Culture On Display
This course looks at the phenomenon of the museum, asking questions about the relation of culture and institutions. How do museums and the selection of what things go into them and the way objects are arranged and displayed shape the way we think about our past, about art? Why are “natural history” and “history” and “art” displayed in different institutions? What are the implications of reproduction for the “original”? Do museums have a future?

488. Philosophy of Art
491. Independent Study
492. The Modern City
493. Master’s Essay
494. Museum Internship
495. Master’s Research Course
500. Reconsidering Roland Barthes
Roland Barthes is one of the most distinguished intellectuals of the last 50 years, and his prolific writings have become a seminal point of reference for the study of literature, film, theater, popular culture, photography, painting, and fashion, among other topics. Yet, more than thirty years after his death, the question of what constitutes his legacy remains unresolved. In this seminar we will consider Barthes’s work, both situating it in its historical context and re-evaluating it with critical hindsight. Students will
be encouraged to situate their own research interests in dialogue with Barthes’s thought.

506. The Sublime
The principal objective of the course is to undertake a reevaluation of the received ideas associated with the operation of the sublime in 18th century art, literature and thought. We will consider first the concept in the writings of Edmund Burke and Immanuel Kant, the better to understand the parameters of a notion that shaped not only 18th century aesthetic theory but also provided the conditions for the advent of Romanticism. Following this groundwork we will consider a series of topics, including the publications of Joseph Wright of Derby, Fuseli’s illustrations to John Milton, the art and poetry of William Blake, the writings of Ralph Waldo Emerson, and the American Sublime. Themes in the course will include the classical sublime, the scientific industrial sublime, the beautiful and the sublime, the picturesque, the natural sublime, the transcendental sublime; and the romantic sublime.

507. Rhetoric of the Frame
The task of any discussion of frames and framing in the visual arts whether in painting, sculpture, film, performance, architecture, graphic novels and cartoon strips, or digital media - is first and foremost to counter the tendency of framing devices to invisibility with respect to the artwork they supposedly contain. We see the work, but we do not see the frame. It is against this tendency to ignore the frame that this seminar is directed. At first glance the frame may seem to be as unproblematic. Starting from a consideration of the foundational texts of frame theory in the philosophy of Immanuel Kant, we will examine the discursive limits of the material and non-material border in the writings of, among others, Mayer Schapiro, Martin Heidegger, Jean-Claude Lebensztejn, Louis Marin, Craig Owens, and Jacques Derrida.

508. Mimesis: Theory & Practice

511. Dance, Art, and Film
This course explores relations among dance, art, and film at significant moments in the 20th & 21st centuries. We will study instances in which the forms are closely aligned, including the famous productions by artists Gontcharova, Picasso, & Matisse, for Diaghilev’s Ballets Russes; Martha Graham’s partnership with Isamu Noguchi; & Merce Cunningham’s work with Robert Rauschenberg. We will look simply at how dance is filmed or how dance uses film. The course will concentrate on two figures of the postwar American avant-garde: Merce Cunningham & Yvonne Rainer. Cunningham’s dances choreographed for film in collaboration with film & video makers & Rainer’s move from choreography to filmmaking & eventually to hybrids of the two will constitute the core of the course. Other major figures will be explored: choreographers George Balanchine, Doris Humphrey, Trisha Brown, William Forsythe, Anne Teresa De Keersmaeker; & filmmakers Maya Deren, Ed Emshwiller; Babette Mangolte, Dominique Delouche, Thierry de May, etc.

513. Architecture, Photography, Modernism/Postmodernism
The subject of this course is inspired by a series of photographs commissioned from Hiroshi Sugimoto for the Los Angeles Museum of Contemporary Arts’ exhibition At the End of the Century: One Hundred Years of Architecture. Sugimoto’s photographs show canonical works of modern architecture shot out of focus, reduced to both icon and phantom. The seminar considers the changing relations between photography and architecture, between image and space, between picture and object from the advent of modernism to the present. The course looks at these relations in the New Objectivity and the New Vision, Surrealism, the International Style, Mid-Century Modern, and ends by considering the uses of the photography of architecture in Conceptual art and the fascination with modernist architecture in contemporary photographic work. Students read critical studies of modernist architecture and photography and plot the relations between these discourses and practices.

514. Itinerant Things

516. Photography & the Everyday

517. Street Photography

519. Material Culture
This upper-level course interrogates the cultural meaning of things in an increasingly digital age. Paying attention to objects in their native as well as virtual frameworks, we will look at a variety of media (film, photography, fine art, popular culture) in material and on-line contexts to investigate paradigm shifts in 21st century scholarship, archiving, and understanding of material culture.

520. The Politics of Space
Spring 2010. Please see AH 320 for description.

520M. The Politics of Space

521. Word and Image
Prerequisite: Permission of Instructor
The connection between word and image is foundational to the study of both art and literature. Whether the interaction is one of collaboration or hostility, study of the relationship between verbal and visual languages reveals their mutual interdependence on a multiplicity of levels. From consideration of the so-called ‘sister arts’ of painting and poetry and the role of titles, captions and illustrations to the interaction of the verbal and the visual in graphic novels and ekphrastic criticism, word and image cannot be separated. This course will address a selection of readings and topics designed to introduce the student to a broad range of themes and issues within word and image studies.

523. Materiality in Architecture
525. Authorship: Anxiety of Influence

Authorship is a key issue in both contemporary art practices and in visual culture, where it is frequently dispersed by social groups, by mediums (including such loosely defined “mediums” as the city or the public), and even theoretical frameworks (e.g., of post-nationality, postracial identity, or the problematic of equality). This course lays out the prehistory of contemporary approaches to authorship in critical theory and practice. It is a reading-intensive seminar based on weekly discussions and the development of individual research projects.

540. The Art of Industry

Prerequisite: Field trips in the Rochester area will be a critical aspect of the class. Students will be encouraged to develop a digital component to a term research project in consultation with the instructor.

Where do technological rationalism and aesthetic beauty converge? The course will address this question through an examination of things and places produced from the advent of the Industrial Revolution to the present, with a specific emphasis on the built environment as well as global contexts of industrial production. Theoretical and primary texts, including works by Marx, Benjamin, Loos, Le Corbusier, Kracauer, Banham and Appadurai, will contextualize a series of thematic concerns including the rise of an industrial vernacular, the “machine aesthetic,” the interrelationship of form and function, international transmutations of technology, Taylorism and Fordism, mass production and the industrial ruin. Subjects considered will include factories and plants, mass housing systems, objects of industrial design as well as artistic representations thereof. The course will be rooted in discussion but may be supplemented by formal presentations as appropriate.

541. Art of Infrastructure

554. Films of Jean-Luc Godard

This course will survey the career of Jean-Luc Godard from Breathless (1959) to In Praise of Love (2001). Through close analysis of his films and range of critical responses we will explore numerous issues that Godard places before us as spectators and critics. While Godard is perhaps most famous, even notorious, for his commitment to politically engaged cinema, his interests in history and aesthetics remain central across this diverse corpus. Although he is known for his experiments in style and medium, he also remains committed to traditional film history and art history. We will explore the complex relationships his films establish between image and word, between sound and image, between stillness and motion. Our analyses will examine the central importance of literature and art history, as well as of popular culture, to the individual films and the corpus as a whole.

555. Feminist Film Theory

Feminism has had a powerful impact on the developing field of film theory from the 1970s to the present. This course will examine the major feminist work on film, moving from the earlier text-based psychoanalytic theories of representation to theories of feminine spectatorship to studies of reception contexts and audience. We will also give attention to the very important role of feminist theory in television studies. Weekly screenings, keyed to the readings, will allow us to test the value of these positions for close critical analysis of the film or television text. Readings to include: Laura Mulvey, Kaja Silverman, Constance Penley, Judith Mayne, Linda Williams, Jacqueline Bobo, Valerie Smith, Lynn Spigel, Lynne Joyrich, Julie D’Acci.

561. Classical Film Theory

Prerequisite: FMS 132 - Intro to Art of Film OR FMS 131 - Intro to Media Studies

This course examines the philosophical, aesthetic, and social issues that are central to classical film theory. It traces the historical development of film theory from 1900 to the 1950s. We will begin with on thinkers in the period of early cinema, including Germaine Dulac, Jean and Marie Epstein, and then we will examine the development of film theory in the work of later theorists, such as Jean Mitry, Sergei Eisenstein, Dziga Vertov, Siegfried Kracauer, Walter Benjamin, Andre Bazin and Christian Metz. Weekly screenings of historically contemporary films will allow us to examine the ongoing dialogue between the evolving medium and the developing theoretical discussion.

583. Visual & Cultural Studies

The Colloquium introduces students in the Visual and Cultural Studies Program to aspects of the histories, theories, and methodologies of our field of study. We proceed in three ways: First, we read and discuss together a series of texts on and in visual and cultural studies. Second, various faculty members in the program conduct sessions in their areas of expertise based on readings that they select for us. And third, each student presents his or her own work to the colloquium. For this final part, it is important that students engage with visual and cultural studies models and provide relevant readings to other members of the colloquium.

584. Research Seminar in Vcs

This course is designed to help students rewrite seminar papers towards either publication or use in a dissertation. It is also designed to teach students to become better editors (of others as well as of their own work). Interested students must enter with a project they want to work on (a term paper at least 15-20 pp in length). A two-credit course, it will meet as needed (depending on the number of students) at times and places TBA. Open only to VCS students in coursework.

585. Visual Culture of Heritage

586V. York Wun PhD Visiting Studnt

590. PhD Readings

591. Independent Study
594. PhD Research Internship

595. PhD Res/Vis & Cultrl Studies

595A. PhD Research in Absentia

595B. PhD Rsrch in Absentia Abroad

598. Senior Seminar: contemporary Art

Prerequisite: Introduction to VCS or Introduction to Art History

The Seminar in Contemporary Art is a course designed to bring together studio art and art history majors and minors in an extended discussion of contemporary artistic practices. We often look backwards to the 1960s or earlier but usually focus on a method, issue, or aspect to contemporary art (e.g. participation; photography; authorship). This course prepares students for critical engagement with contemporary art practices and can serve as an excellent preparation for Art New York or for a career in the arts.

890. Summer in Residence - MA

895. Cont of Masters Enr

897. Masters Dissertation

897A. Ms Dissertatn in Absentia

899. Master’s Thesis

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

997A. Doct Dissertatn in Absentia

997B. Doc Diss in-Absentia Abroad

999. Doctoral Dissertation

999A. Doct Dissertatn in Absentia

999B. Doc Diss in-Absentia Abroad
Biology

Professors Bi, Culver, Eickbush, Goldfarb, Gorbunova, Jaenike, Orr, Presgraves, Seluanov, Sia, Welte (Chair), Werren
Associate Professors Benyajati, Fry, Lambert, Seluanov
Assistant Professors Bergstrahl, Brisson, Chen, Fay, Fu,
Ghaemmaghami, Larracuente
Joint Appointments: Assistant Professor Oakes, Associate Professor Portman

The Department of Biology offers programs of research and study leading to the MS and PhD degrees in a broad spectrum of disciplines, with special emphasis on the areas of molecular, cellular, and developmental biology and evolution, ecology, genetics, and genomics.

PhD Curricula

The aim of these programs is preparation of independent professional biologists, qualified for teaching and scholarly research at the college and graduate levels or for positions of leadership in industrial research. Award of the doctorate recognizes the following achievements: breadth of general knowledge in biology, research expertise in one or more areas of contemporary specialization, mastery of related disciplines (e.g., mathematics, chemistry, physics, or computer science) as appropriate to the area of specialization, skill in analysis and in written and oral communication of scientific information, and at least one major contribution toward the solution of a significant biological problem, presented in the form of a scholarly dissertation.

Formal course requirements are kept to a minimum in order to give students and their advisors the opportunity to design individual programs of study appropriate to the student's interest and preparation, and to provide students with the opportunity to take advantage of educational resources throughout the University. Many such opportunities exist in other departments and institutes, especially those in the adjacent medical school.

Students entering with the baccalaureate in science and adequate preparation in biology normally complete the doctorate in five to six years. The first year of graduate work includes both formal coursework and research experience. Courses are selected in consultation with faculty advisors to fill gaps in undergraduate preparation (if any), to assist the student in identifying an area of special interest for research, and to achieve an appropriate balance between breadth of preparation and intensive study in a chosen subdiscipline. Research in the first year is carried out in a rotation through three different laboratories. Students work on short projects that introduce them to the investigations in each laboratory and provide a basic repertoire of research skills. Students begin their PhD research in the laboratory of a chosen faculty member at the end of the first year.

Admission to candidacy for the PhD degree requires successful completion of an oral examination, which includes defense of a thesis proposal. This exam is normally completed by the end of the second year. Periodic meetings with a thesis advisory committee are required to aid the student in critically evaluating results, assigning priorities, and considering alternative experimental strategies.

The PhD degree is awarded following the successful defense of a written dissertation before a committee of examiners.

Teaching Requirement

Graduate students make a valuable contribution to the instructional programs of the department as teaching assistants in recitation sections or in laboratory courses. All candidates for the PhD degree are required to assist in the teaching of a minimum of two courses. Additional teaching effort is required of students supported as teaching assistants.

MS Curricula

The purpose of these programs is to provide advanced training in biology for those whose goals do not call for establishment of independent research laboratories or for training of postgraduate students. Applicants for MS candidacy include those in school science teaching, and those preparing for nonacademic careers requiring strong preparation in biology, including research positions in the health professions or industry. The MS recognizes competence in selected subdisciplines demonstrated by successful completion of a coherent set of courses, and, either defense of a thesis based upon independent research (Plan A) or adequate performance in a special comprehensive examination (Plan B). Students electing Plan B must offer the equivalent of four credit hours in laboratory work, completed in the form of graduate laboratory courses, as independent investigation, or by some combination of the two. The time required to complete Plan A is two–three years and the time required to complete Plan B is one–two years.

Prerequisites

Most applicants for graduate work in biology have completed BS or BA curricula with majors either in biological sciences or in a related science including at least five courses in biology. Minimum preparation in physics, calculus, and organic chemistry is normally one year of each. Deficiencies in particular undergraduate courses do not necessarily weaken an application if preparation is otherwise strong, and aptitude is clearly demonstrated. Any such deficiencies should be made up early in the graduate program by attendance at appropriate graduate courses or, if necessary, at undergraduate courses which do not carry graduate credit.

402. Molecular Biology

This course deals with the molecular mechanisms of gene replication, gene expression, and the control of gene expression in both prokaryotic and eukaryotic cells. Topics include enzymatic mechanisms of DNA replication, recombination and repair; transposable elements; DNA transcription; RNA splicing; RNA translation; repressors, activators, and attenuators; recombinant DNA and genetic engineering. (Fall)
405. Evolution
Fundamentals of Evolution. Topics include the history of evolutionary thought, population and quantitative genetics, molecular evolution, the history of life, speciation, and human evolution. (Spring)

406. Eukaryotic Genomes
A course that discusses the remarkable diversity of eukaryotic genomes with an emphasis on the human genome. The course will emphasize the importance of understanding the forces of evolution to explain molecular and genetic topics such as the large variation in genome size and structure as well as the remarkable complexity of gene regulation. (Spring)

419. Genomics of Quant Traits
Prerequisites: BIO 190 OR 198, BIO 214 or equivalent
Human body size, behavior and many diseases are quantitative traits; they vary continuously and are determined by a large number of genes. The study of quantitative traits can provide insights into the genes underlying disease and how species have evolved. This course will cover the identification and analysis of genes affecting quantitative traits and the evolutionary forces that influence genes and genomes in animal model systems. These studies are increasingly being used in humans and are the future of modern medicine. The lab component will provide students a hands-on introduction to the computational methods. Labs will be primarily conducted using R. (Fall Spring)

419P. Genomics of Quant Traits Lab

420. Advanced Cell Biology
An advanced course focusing on a mechanistic understanding of cellular organization and function. This course relies heavily on the primary research literature, classic and recent, and the design and interpretation of experiments, drawn from biochemistry, microscopy and genetics. Topics include the cytoskeleton, membrane traffic, cell-cell signaling and the cell cycle. (Fall)

422. Biology of Aging
This course focuses on molecular mechanisms of aging. We will discuss popular theories of aging, model organisms used in aging research, evolution of aging, relation between aging and cancer, human progeroid syndromes, and interventions to slow aging. (Fall)

426. Developmental Biology
This course deals with the cellular and molecular aspects of animal development, with emphasis on processes and underlying mechanisms. Topics include: embryonic cleavage, gastrulation, early development of model vertebrates and invertebrates, patterning of cell fates along embryonic axes of Drosophila and vertebrates, organogenesis, and stem cells. (Fall)

443. Eukaryotic Gene Regulation
This advanced course examines mechanisms of chromatin-mediated regulation of gene expression, relating molecular structures, dynamic interactions, nuclear processes, 3-D nuclear organization to biological functions. Lectures and readings draw heavily on primary literature both classic and most recent. (Spring)

453. Computational Biology
Prerequisite: Permission of instructor
The course will provide an introduction to computational approaches to biological problems, including the theory, algorithms and methods used in the analysis and interpretation of genomes. The course will cover alignment, assembly, motifs, evolutionary models, Markov models (HMM and MCMC), expectation maximization and machine learning methods used to interpret genomes and address problems in comparative genomics, population genomics and metagenomics. The computer lab BIO 453P is required and will provide an introduction to the linux command line, python and writing scripts to implement methods in computational biology. (Spring)

453P. Computational Biology Lab
Prerequisite: Concurrent enrollment in BIO 453
This lab will provide a practical introduction to computational biology through the use and writing of scripts to solve problems. Computer programming skills and computer science coursework are not required. Instead students will be introduced to working within command line environments and the python scripting language. The lab will involve writing scripts to implement algorithms in computational biology and interpreting the results based on BIO 453 lectures. (Spring)

457. Applied Genomics
Prerequisite: BIO 198/190
This course is designed to teach students how the fast-moving field of genomics is applied to address important biological problems. Students will get hands-on training in genome analysis techniques and functional genomics. Major topics covered include genome sequencing, assembly and analysis, functional genomics, population genomics and genome evolution. (Fall)

460. Animal Behavior
Examines animal behavior from an ecological and evolutionary perspective. Topics include social organization, mating systems, foraging, aggression, animal learning, and quantitative techniques in behavioral biology. (Fall)

463. Ecology
A survey of adaptations to the physical environment, dynamics of natural populations, interactions between species, and human impacts on the environment. (Fall)
468. Laboratory in Molecular, Cell and Developmental Biology
This course is designed to provide (1) introduction to model organisms (2) training in specific methods used in molecular, cell and developmental biology research, with emphasis on data acquisition and analysis (3) experience in the design and execution of experiments, reading and writing scientific reports, and public scientific presentation. (Spring)

471. Advanced Ecology and Evolutionary Biology A
A four-course sequence that provides comprehensive coverage of advanced topics in ecology and evolutionary biology. Areas covered include: population and community ecology; population and quantitative genetics; molecular evolution; evolutionary genomics; evo-devo; phylogenetics; and speciation. This course is intended for graduate students; exceptional undergraduate students can enroll by permission of the course coordinator. (Fall)

472. Advanced Ecology and Evolutionary Biology B
A four-course sequence that provides comprehensive coverage of advanced topics in ecology and evolutionary biology. Areas covered include: population and community ecology; population and quantitative genetics; molecular evolution; evolutionary genomics; evo-devo; phylogenetics; and speciation. This course is intended for graduate students; exceptional undergraduate students can enroll by permission of the course coordinator. (Spring)

473. Advanced Ecology and Evolutionary Biology C
A four-course sequence that provides comprehensive coverage of advanced topics in ecology and evolutionary biology. Areas covered include: population and community ecology; population and quantitative genetics; molecular evolution; evolutionary genomics; evo-devo; phylogenetics; and speciation. This course is intended for graduate students; exceptional undergraduate students can enroll by permission of the course coordinator. (Fall)

474. Advanced Ecology and Evolutionary Biology D
A four-course sequence that provides comprehensive coverage of advanced topics in ecology and evolutionary biology. Areas covered include: population and community ecology; population and quantitative genetics; molecular evolution; evolutionary genomics; evo-devo; phylogenetics; and speciation. This course is intended for graduate students; exceptional undergraduate students can enroll by permission of the course coordinator. (Spring)

480. Graduate Lab Rotation
An introduction to research in the laboratories of individual faculty members. (Fall Spring)

516. Cell/Dev/Mol Biology Sem
This one credit course examines current topics in cell, developmental and molecular biology. Student-led seminars and discussions based on representative publications in the recent literature. One or several broad topics, drawn from active fields of cell, developmental and molecular biology, will be covered each semester. (Fall)

517. Graduate Research Seminar
Ph.D. students prepare and present their research findings to the Department. This course carries one credit. (Spring)

580. Journal Club in Ecology & Evolution
Current topics in ecology and evolutionary biology are explored by reading research and review papers. Students choose topics for reading and lead discussions of their chosen topics. This course carries one credit. (Fall Spring)

581. Topics in Cell, dev & Mol Biol
This two-credit course will be taught by all faculty members of the Biology Department that conduct research in the areas of Cellular, Developmental and Molecular Biology. Each week one faculty will provide a general introduction to his/her field of interest and a comprehensive overview of their own research efforts. Short (1-2 page) papers will be assigned throughout the course, critiqued and returned for rewriting. Grades will be determined by participation in class discussions and the assigned writings. (Fall)
Brain and Cognitive Sciences

Professors DeAngelis (Chair), Jacobs, Jaeger, Rucci, Tanenhaus
Associate Professors Cantlon, Mahon, Tadin
Assistant Professors Haefner, Kidd, Kurumada, Mitchell, Piantadosi, Raizada
Joint Appointments: Professors Carlson, Duffy, Haber, Huxlin, Marvin, McDonough, Merigan, Mink, Pasternak, Runner, Schieber, Temperley, Williams; Associate Professors Bennetto, Romanski; Assistant Professor Lin, Poletti, Snyder

Members of the Department of Brain and Cognitive Sciences study how we see and hear, move, learn and remember, reason, produce and understand spoken and signed languages, and how these remarkable capabilities depend upon the workings of the brain. They also study how these capabilities develop during infancy and childhood, and how the brain matures and becomes organized to perform complex behavior.

The department offers a program of graduate study leading to the degree of Doctor of Philosophy. The PhD program emphasizes training in a range of research methods and concepts that drive the brain and cognitive sciences. While the focus is always on behavior and the brain activity that underlies it, students are encouraged to undertake projects in several laboratories that use different research methods, and to develop real expertise in some area of specialization.

The department’s research programs span a large domain in the behavioral, neural, and computational sciences. All of it is connected by the idea that to understand behavior we must study not only behavior but also the processes—both neural and computational—that underlie it. While the faculty have active research programs in many regions of this large domain, the department, in conjunction with the surrounding University community, has notable strength in the study of vision, natural language, cognitive neuroscience, computational modeling, and learning and plasticity during development.

The PhD curriculum has a core designed to introduce students to parts of the domain they might not previously have studied, and to prepare them for advanced work. This core curriculum covers a range of topics in perception, action, cognition, language, learning, and development, each examined from the perspectives of behavioral, computational, and neural science. The methods students master for approaching their own research may vary. However, as preparation for entering a highly interdisciplinary field, all students must acquire some expertise in at least two approaches. Students also take advanced courses and seminars in one or more areas of specialization. At all stages of their graduate careers, students are heavily engaged in research. Generally, students complete most of their coursework during the first two years. During the third year, students take a qualifying exam, covering the scholarly literature surrounding their area of specialization, and thereafter typically devote themselves fully to their research. The PhD is awarded upon the completion of a dissertation containing original research in the field. The department does not offer a program leading to a master’s degree.

Students admitted to the program come from a variety of backgrounds, some in disciplines closely related to ours (e.g., psychology, neuroscience, computer science, cognitive science, linguistics), others in branches of the natural sciences or engineering that are less obviously relevant to our domain. This richness of backgrounds is a source of great strength to the program, because our students bring to it new ways of thinking about scientific problems. Although we do not stipulate the kinds of backgrounds students should have, we do expect applicants for admission to have outstanding academic records, and to be able to demonstrate their capacity for formal thinking and clear expression of ideas.

All students admitted to the program are offered graduate fellowships that provide a competitive 12-month stipend and cover the costs of tuition and other fees. Support is guaranteed for four years subject to satisfactory academic progress. The department does not distinguish teaching fellows and research assistants; all students are provided with a fellowship to support their research training, and all contribute to the department’s teaching by serving as teaching assistants or teachers of small classes. Students are asked to serve as teaching assistants for three courses during tenure of their fellowships. Where appropriate, students are encouraged to seek personal fellowships from bodies such as the National Science Foundation or the National Institutes of Health, for this brings distinction both to the student and the department; however, admission to the program is never contingent on students securing their own funds.

435. Natural Language Processing
491. Master’s Readings
493. Master’s Special Topics
501. Language
An interdisciplinary introduction to the field of natural language, emphasizing behavioral, linguistic, and computational perspectives. Topics include language structure, production, comprehension, and acquisition
502. Cognition
An interdisciplinary introduction to cognition. Topics covered include learning, memory, attention, concepts and categories, cognitive development, and reasoning, each considered from the perspectives of behavioral study, computational processes, and neural mechanisms.
504. Sensory Systems
An introduction to the functioning of the senses and the physiological mechanisms underlying them. Topics include vision, audition, somatosensation, the vestibular system, gestation and olfaction, with an emphasis on the general principles that govern mammalian sensory systems.
505. Perception & Motor Systems
An interdisciplinary introduction to perception and action. Topics covered include the perception of motion, depth, surfaces, pattern and object perception, eye movements, motor planning and organization, and attention.

507. Basic Neurobiology

507P. Basic Neurobiology Lab

508. Cognitive Neuroscience
General introduction to neuroscientific studies of various aspects of human cognition and perception, e.g. object-recognition, development, attention, language, vision, etc. The class will consist both of lectures and also seminar-type discussions led by the students.

510. Data Analysis I
Issues of data analysis in experimental research. The course focuses on parametric techniques, specifically analysis of variance. Topics covered include simple and complex designs for between and within subjects factors, including mixed designs; analysis of covariance and trend and contrasts. The course includes a lab in which students are taught to use a popular statistical package for data analysis.

511. Behavioral Methods in Cognitive Science
This course reviews the leading methods used to investigate cognitive skills and/or their neural substrate in humans. The course is divided into several sections: accuracy and psychophysics; RT and processing states; interference, neighborhood effects and system dynamics; investigations of natural data; brain imaging methods as applied to the cognitive sciences; and issues when studying special populations such as infants, patients, animals or any non-compliant subject. Technical articles on each technique are discussed in combination with specific illustrations of how each has been used to investigate research questions.

512. Computational Methods in Cognitive Science
Prerequisites: Includes knowledge of calculus. Knowledge of linear algebra and probability theory will also be helpful (though prior knowledge of these areas is not strictly required). Homeworks require students to write computer programs (preferably in MatLab).

This course focuses on: (a) statistical tools that are useful for revealing structure in experimental data; and (b) representation and learning in statistical systems and the implications of these systems for the study of cognitive processes. Examples of the applications of computational methods from the cognitive neuroscience literature are examined throughout the course.

Topics covered include: principal component analysis, multi-dimensional scaling, hierarchical and non-hierarchical clustering, regression, classification, time series modeling via hidden Markov models and Kalman filters, Hebbian learning, competitive learning, maximum likelihood estimation, and Bayesian estimation.

513. Intro to Fmri: Imaging, Computational Analysis, & Neural Representations
Prerequisite: Prior programming experience (esp. Matlab) recommended.

The core focus of the course will be on how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing. Some of the questions that the course will address include: 1) The basic FMRI signal just shows activation in different parts of the brain. How can we get from that to addressing questions about neural representations and neural information processing? 2) Ways of relating neural activation to behavioural performance. Can fMRI provide information over and above what can be obtained from behaviour alone? 3) Standard fMRI analysis using the General Linear Model, including preprocessing steps. 4) Multivariate fMRI analysis using machine learning approaches. There will also be a component, about 20% of the class, on the big-picture aspects of MRI physics and physiology which make fMRI possible.

514. Lab in Neurobiology
The first part of the course entails structured laboratory experiments to provide experience with neuroanatomical, neurophysiological and molecular biological approaches to studying neural organization and function. The course concludes with one of two 5-week long research projects that culminate in the production of a final research paper. In one project, students explore laterality in the basal ganglia and its influence on motor behavior. In the other project, students explore the molecular genetics of touch sensation in nematodes.

521. Auditory Perception
This course considers how we comprehend the auditory environment. Topics include the physical stimulus for hearing, the physiology of the auditory system (both at the periphery and in the central nervous system), the psychophysics of basic auditory perception (e.g., hearing thresholds), higher level auditory perception (including auditory scene analysis and the perception of complex auditory events such as speech and music), and hearing disorders. Considers research from a diverse range of perspectives including behavioral research, cognitive neuroscience, studies of individual differences, and research that adopts a comparative perspective.

524. Multisensory Processing
This is a reading seminar that will look at modern research on statistical learning in a number of areas in perception, action and cognition. The course will focus on studies of how the brain adapts to the statistics of both sensory inputs and motor outputs with the goal of finding common conceptual links between diverse behavioral domains, including, sensory adaptation, motor adaptation and learning, visual perception, language processing and various cognitive functions (e.g. causal learning). (Spring)
528. Special Topics in Vision
Advanced graduate seminar on a chose problem in vision sciences. In previous years, topics have included motion perception, stereopsis, color vision and visuo-motor control. Readings for the course are drawn from the scientific literature in the topic being covered. Students are typically required to lead discussions on papers. (Fall Spring)

530. Data-Enabled Research
This course provides a hand-on introduction to experimental and analytical methods in cognitive science and artificial intelligence. Each year, it offers three modules from a rotating list, including topics such as brain imaging, computational linguistics, and computer vision. The course is open to graduate students in any discipline. The course is recommended for who intend to pursue research in the intersection of cognitive science and computer science, but prior experience in those fields is not required.

531. Practicum Data-Enabled
Prerequisite: BCS 530
In this interdisciplinary project course, graduate students will work in mixed teams to develop an artifact that addresses a research question and/or infrastructure need in the intersection of cognitive science and artificial intelligence. Students will learn principles of design by participating in the stages of brainstorming, specification, initial design, prototyping, refinement, and evaluation. The artifacts created by this course could include online showcases, demonstrations, tutorials, blogs, scientific papers, and software components to support further research.

532. Probabilistic Theories of Cognitive Processing
Prerequisite: BCS 512/CSC 512 (or permission of the instructor)
This course is a graduate-level seminar intended to teach students about state-of-the-art probabilistic theories of human cognitive processing. Topics covered include theories of language, perception, categorization, numerical cognition, and decision making.

533. Statistical Speech & Language Processing
Prerequisite: CSC 440
An introduction to statistical natural language processing and automatic speech recognition techniques. This course presents the theory and practice behind the recently developed language processing technologies that enable applications such as speech-driven dictation systems, document search engines (e.g., finding web pages) and automatic machine translation.

535. Natural Language Processing
An introduction to natural language processing: constructing computer programs that understand natural language. Topics include parsing, semantic analysis, and knowledge representation.

536. Machine Vision
Introduction to computer vision, including camera models, basic image processing, pattern and object recognition, and elements of human vision. Specific topics include geometric issues, statistical models, Hough transforms, color theory, texture, and optic flow.

537. Information Theory & Complexity in Cognition & Neuroscience
This seminar will present the fundamentals of information theory with applications to cognitive and neural systems. The course will closely follow textbooks by Cover & Thomas and Li & Vitanyi, aiming to combine mathematical foundations with applications to research. Covered topics will include probability, surprisal, entropy, mutual information, channel capacity, coding theory, and differential entropy. The course will also cover formal measures of complexity, including Kolmogorov complexity and related notions of data compression, minimum description length, and their relationship to learning and inference. Students taking the course for credit or auditing will present papers using these ideas across cognitive science and neuroscience.

541. Integrative Neuroscience
see NSC 531

542. Neuropsychology
Examines clinical neuropsychology, which bridges neurology, neuroscience, and clinical psychology. Covers history of clinical neuropsychology, principles of neuropsychological assessment, and the interpretation of cognition and behavior as they relate to brain dysfunction. Considers specific neurological syndromes including neurodegenerative, cerebrovascular, toxic, and memory disorders; epilepsy; head trauma; infectious processes; pediatric neuropsychology; psychiatric syndromes; and forensic neuropsychology. Patient presentations (videotape and in-person interviews) supplement lectures.

543. Neurochemical Foundations of Behavior
Introduces the field of neurochemistry with an emphasis on cellular and molecular neurochemistry. Topics range from study of neurochemical mechanisms that underlie normal neural function to discussion of behavioral disturbances that result from neurochemical abnormalities. Considers neurochemical mechanisms of adaptive behavior, learning and memory, behavioral disorders, gender differences, and drug seeking behavior.

546. Biology of Mental Disorders
Examines the neurobiology of anxiety/phobic conditions, mood disorders, and chronic psychotic states, particularly schizophrenia. Considers definitions of psychiatric syndromes, the problems of diagnosis, brain organization, and neurotransmitter systems involved in state functions. Introduces research approaches including epidemiologic, phenomenologic, family/adoptive,
longitudinal descriptive, psychophysiologic, neuropharmacologic, genetic linkage, and postmortem studies; emphasizes recent in vivo brain imaging and neuroreceptor studies.

547. Introduction to Computational Neuroscience
Prerequisites: Graduate standing in BCS, NSC, or CS, or permission of instructor.

A review of recent progress in computational theories of the brain, emphasizing theories of representation and computation in neural circuits. The course begins with biophysical models of neurons and end with models of complex cognitive functions such as sensory motor transformations or sentence processing.

548. Neuroeconomics

We will discuss the neuroscience and psychology underlying reward-based decisions. Topics of discussion will include behavioral economics, neuroimaging studies of consumer behavior, physiological studies of the reward system, and computational models of choice and reinforcement learning. Students will be expected to read several scholarly articles each week, attend lectures, and participate in discussions.

549. Developmental Neurobiology

Advanced treatment of the development of the nervous system, including the nature/nurture issue and factors that influence the development of neural organization and function. Topics include the production, migration, differentiation and survival of neurons; functional specialization of neural regions; axonal navigation; target mapping. Compares and contrasts developmental plasticity with forms of neural plasticity exhibited in adults.

550. Development of Mind

A survey of the major topics and issues in development. The course covers the development of sensation, perception, cognition, and language in humans, as well as the development of neural mechanisms and systems in other species. A major theme involves the nature/nurture issue, including the interacting roles of experience and maturation, the constraints on plasticity provided by maturation (for example, in critical period phenomena), and the differences and similarities between development and learning.

555. Language Acquisition

The course covers a broad range of topics on the child’s acquisition of a native language, including literature on the acquisition of spoken and signed languages, as well as theories of the language learning process. Focus is on the acquisition of syntax and morphology.

560. Proseminar in Music Cognition

The objective of this course is to engage in professional-level music-cognitive research. The course surveys primary research in the field of music cognition and functions as a laboratory course in experimental method. Students discuss and critique experimental studies published in journals and monographs. In addition, the class works collaboratively to build skills in experimental design and data analysis via readings and class demonstrations/activities. Each student is expected to design and run an empirical experiment or computational project as a final research paper.

562. Language Production

Covers current and classic topics in the field of language production. Topics include speech error models, computational models of lexical/phonological encoding, issues in syntactic encoding, the incrementality of speech production, comprehension vs. production, and hearer vs. speaker-oriented accounts of production processes.

563. Topics in Language Production and Comprehension

his seminar offers an in-depth examination of selected topics in language comprehension, including lexical processing, parsing, and anaphora resolution. Theoretical ideas from linguistics and artificial intelligence are integrated with experimental studies of language processing.

564. Sign Language Structure

An examination of signed languages and the cognitive constraints that shape them, through a detailed consideration of the structure of American Sign Language and other natural signed languages of the world. Includes training in sign language notation and analysis.

566. Topics in Understanding Language

This seminar will focus on selected topics in language processing, for graduate students and faculty in the language sciences. The specific topic for a particular year will be announced.

568. Sign Language Universals and Typology

Crosslinguistic comparisons among signed languages, considering the possible linguistic universals for signed languages, the degree and types of variation among different signed languages, the ways in which universals and language specific variation for signed languages may compare and contrast to those for spoken languages, and the visual, motoric, and cognitive constraints which may give rise to these phenomena.

569. Sign Language Psycholinguistics and Acquisition

Consideration of the processing, historical development, and acquisition of signed languages, with an interest in the ways that language processing, development, and evolution may affect language structure.

581. Music and Language

This course will explore relationships between musical and linguistic structure. In addition to reading and evaluating early writings on the subject by Bernstein and Lerdahl & Jackendoff,
students will assess more recent work by Huron and Patel, and the linguists Hayes and Ladd on prosodic structure. We will also discuss experimental work on prosodic structure in language and on music acquisition in infants. Co-taught by a music theorist and linguist, the course will review basic aspects of phonology, intonational phonology, meter, and memory that are relevant to music. Each student will complete a piece of original research in the form of a term paper and class presentation. Permission of instructor required for non-Eastman students.

582. Grant Writing in Bcs
A workshop in which students will write a proposal for either a pre-doctoral or post-doctoral NRSA fellowship from NIH. Students will review old NRSA proposals, both successful and unsuccessful and analyze the components of a successful proposal. Through process of peer review and discussion, students will write and revise the main sections of an NRSA proposal, culminating in a penultimate proposal that will be reviewed by two mock study sections – one in the class and one by faculty in BCS and CVS. Reviews from these study sections will be returned a week before the deadline for NRSA proposals at NIH. Students are encouraged to use the class to prepare real proposals that they can submit to NIH. (Spring)

591. PhD Readings

595. PhD Research

595A. PhD Research in Absentia

598. Supervised Teaching Assistant

599. Professional Development & Career Planning
The purpose of this 1-credit course is to provide first- and second-year graduate students with a set of guiding principles for optimizing their progression through the PhD program. The following topics will be discussed: fulfilling program requirements, advising and mentoring, time management, conference presentations and journal publications, writing skills for journals and grants, how to juggle, persist, drop, and collaborate in your research projects, the post-PhD job market and qualifications required for success. (Spring)

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

899. Master’s Dissertation

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

997A. Doctoral Dissertation in Absentia

999. Doctoral Dissertation

999A. Doctoral Dissertation in Absentia

999B. PhD in-Absentia Abroad
Chemistry

Professors Boeckman, Bren, Dinnocenzo, Farrar, Frontier, Goodman, Jones, Krauss (Chair), Krugh, Rothberg, Schröder, Turner
Associate Professors Fasan, McCamant, Nilsson
Assistant Professors Franco, Huo, Knowles, Matson, Neidig
Joint Appointment: Professor Tang
Cluster Members Professors DeLouise, Dunman, Ermolenko, Ghaemmaghami, Grossfield, Kielkopf, Krysan, Mathews, Miller, Mukaibo, Phizicky, Shestopalov, Wedekind

The University of Rochester’s chemistry department is a medium-sized department with a balance between internationally known research and a small student/faculty ratio. The chemistry department is a center for cutting-edge research, where graduate education focuses on instruction leading to the PhD degree.

In the department of chemistry, education through research is the objective. The department has strong research programs in the traditional areas of organic, inorganic, and physical chemistry, as well as in interdisciplinary areas such as chemical physics, photochemistry, nanotechnology, organometallic, biophysical, bioorganic, and bioinorganic chemistry. Collaboration between groups often leads to fruitful cross-disciplinary learning opportunities.

The chemistry department operates a wide variety of sophisticated research instrumentation, available 24 hours a day, which are used by students and faculty in a hands-on way. The availability of major state-of-the-art instrumentation represents one of the special strengths of graduate education at the University.

The chemistry PhD requirements are designed to train students to have broad-based knowledge, experience in independent solution to research problems, and experience in presenting chemistry to an audience. There are a number of aspects to the graduate educational experience at Rochester.

Breadth and Depth

All students enrolled in the PhD program must demonstrate a basic knowledge of chemistry through satisfactory performance on standard ACS exams. These exams are given to all entering students during their first week in the program.

Course Requirements

A total of 20 credit hours of coursework determined by the student’s interests and field of study are required. Students may choose from a variety of intermediate and advanced chemistry courses in all areas of chemistry with the guidance of their advisor. Programs of study can be modified to best address a student’s research needs and interests. Thus, courses in related fields, such as biochemistry, pharmacology, biophysics, physics, optics, and mathematics are also available. Specially designed programs are also available for MD/PhD students.

Teaching

At Rochester, the teaching and research missions of the University are viewed as central and inseparable. Accordingly, all graduate students participate in the teaching program as teaching assistants in undergraduate and graduate courses, usually during their first three semesters.

Qualifying Examinations

Students must pass a set of written qualifying examinations (cumulative exams) by April of their second year. By July 31 of that same year, students must pass an oral qualifying examination, which is based on their proposal for further PhD research.

Seminar Presentation

During the third year of study, students present a departmental seminar on a research topic as is customary within the student’s sub-discipline.

Fourth-Year Review

By the completion of the fourth year of study, the student meets with his or her PhD examination committee to discuss progress leading to a successful completion of the dissertation. The purpose of the meeting is to promote timely completion of the PhD degree, rather than to serve as a second oral examination.

402. Biophysical Chemistry I
Prerequisite: CHM 252 or equivalent

An introduction to the theory and practical application of several major techniques used in the structural characterization of biological macromolecules. These methods include: X-ray crystallography, Small Angle X-ray Scattering, Spectroscopic and Calorimetric Techniques, NMR and Comparative Modeling. The goal is to enable non-specialists to become conversant in the language and principles of the field, as well as to understand the strengths and limitations of various techniques. Paper and presentation. (Spring - even years).

404. Biophysical Chemistry II
Prerequisite: CHM 252 or equivalent

This course explores how fundamental interactions determine the structure, dynamics, and reactivity of proteins and nucleic acids. Examples are taken from the current literature with emphasis on thermodynamic, kinetic, theoretical, and site-directed mutagenesis studies. Paper and presentation. (Spring - odd years).

405. Interface of Chm & Bio

This course will provide an introduction to recent research at the interface of chemistry and biology by focusing on seminars given in various departments. Students will read and discuss selected papers from a speaker’s lab during the week before the seminar, attend the seminar, and then meet with the speakers when they visit. Will be CHM 406. (Spring).
406. Interface of Chm & Bio
This course will provide an introduction to recent research at the interface of chemistry and biology by focusing on seminars given in various departments. Students will read and discuss selected papers from a speaker’s lab during the week before the seminar, attend the seminar, and then meet with the speakers when they visit. (Spring)

411. Inorganic Chemistry I
Prerequisite: Organic chemistry
This course covers descriptive chemistry of main group elements, bonding in inorganic systems, coordination chemistry and the properties and reactions of transition metal complexes. Two 75 minute lectures per week. Three 90 minute examinations plus group projects and problem sets. Cross listed with CHM 211. (Fall)

414. Biological Inorganic Chemistry
Prerequisite: CHM 211/411 or a course in inorganic chemistry or by permission of the instructor
Discussion of the role of metal ions in biological systems, especially enzymes. Uptake and regulation of metals, common spectroscopic techniques used for studying metals, and mechanisms through which they react. Other topics include metal ion toxicity, metal-based drugs, and interaction of metals with nucleic acids. Problem sets and proposal. (Spring)

415. Group Theory
2 credits - Development of symmetry and group theory concepts and scope of applications to chemical problems. Applications include molecular orbital theory, ligand field theory and spectroscopy. (Fall, 1st half of semester.)

416. X-Ray Crystallography
Prerequisites: CHM 211, 411, or 415; some understanding of symmetry operations is expected.
2 Credits (formerly CHM 417)
Students will learn the basic principles of X-ray diffraction, symmetry, and space groups. Students will also experience the single crystal diffraction experiment, which includes crystal mounting, data collection, structure solution and refinement, and the reporting of crystallographic data. Weekly assignments: problem sets, simple lab work, or computer work. (Spring, 2nd half of semester.)

417. X-Ray Crystallography
2 Credits (formerly CHM 417)
Students will learn the basic principles of X-ray diffraction, symmetry, and space groups. Students will also experience the single crystal diffraction experiment, which includes crystal mounting, data collection, structure solution and refinement, and the reporting of crystallographic data. Weekly assignments: problem sets, simple lab work, or computer work. (Offered: spring, 2nd half of semester.)

418. Small Molecule Activation
Prerequisites: CHM 421 required, CHM 422 preferred
This course will cover recent developments in the field of homogeneous catalysis in inorganic chemistry as it relates to the multielectron functionalization of molecules. Topics will include water oxidation, nitrogen fixation, and carbon dioxide reduction. (Spring)

421. Basic Organometallic Chemistry
2 credits
Examination of the concepts, systems, reactions and applications of organometallic chemistry. Structure and bonding of complexes having carbonyl, alkyl, carbene, olefin, CnHn and related pi ligands. Oxidative addition, insertion, elimination reactions, and other fundamental reactions of organometallic compounds. (Fall, 2nd half of semester)

422. Organometallic Chemistry
Prerequisite: CHM 421
2 credits (formerly CHM 423)
Mechanisms in organometallic reactions. Applications of organometallic compounds in homogeneous catalysis, polymerization, metathesis. (Spring, 1st half of semester).

423. NMR Spectroscopy
Prerequisites: One year of organic chemistry and one semester of physical chemistry (CHM 251) or equivalents
2 credits (formerly CHM 422)
An introduction to NMR spectroscopy. Collection, processing, and interpretation of homonuclear and heteronuclear 1D and multidimensional spectra will be covered. Topics to be discussed include chemical shifts, relaxation, and exchange phenomena. Examples from organic, inorganic, and biological chemistry will be used. (Fall, 1st half of semester).

424. Phys Methods in Inorganic Chm
Prerequisite: CHM 211/411 or a course in inorganic chemistry or by permission of the instructor; CHM 423 (formerly CHM 423) - NMR Spectroscopy strongly recommended
2 credits (formerly CHM 424)
Molecular and electronic structure determination of inorganic compounds and metal complexes; spectroscopic and physical methods. (Fall - 2nd half semester).

425. Physical Methods in Inorganic Chemistry
Prerequisites: CHM 211/411 and CHM 415; a strong working knowledge of group theory can substitute for the CHM 415 requirement with the permission of the instructor.
Molecular and electronic structure determination of inorganic compounds and metal complexes; spectroscopic and physical methods that are used in inorganic chemistry. The main focus will be practical rather than theoretical. The course will culminate in a project that combines techniques to answer questions about coordination complexes. (Spring semester, 4 credits)
426. Phys Mthds in Inorgnc Chm
Prerequisites: CHM 415 (Group Theory) and CHM 425 (Physical Inorganic Methods I). A strong working knowledge of group theory can substitute for the CHM 415 requirement with the permission of the instructor.

A continuation of CHM 425. The modern methods and tools employed for the determination of the structure of complex organic molecules will be discussed. Among the areas discussed are basic NMR, IR, UV and mass spectroscopy. Problem solving techniques will be illustrated and problem solving skills developed by means of problem sets and class examples. (2 credits, Spring, 1st half semester).

427. Organic Structure Determination
Prerequisite: CHM 423 NMR Spectroscopy (formerly CHM 422) 2 credits (formerly CHM 426).

The modern methods and tools employed for the determination of the structure of complex organic molecules will be discussed. Among the areas discussed are basic NMR, IR, UV and mass spectroscopy. Problem solving techniques will be illustrated and problem solving skills developed by means of problem sets and class examples. (Fall, 2nd half of semester).

433. Advanced Physical Organic Chemistry I
Prerequisite: One year of organic chemistry or equivalent

An understanding of the structure and reactivity of organic compounds by using molecular orbital theory will be provided. Some perspectives on the relationships between structure, mechanism and reactivity will be discussed in the context of a number of fundamental concepts and principles, such as molecular orbital theory, frontier molecular orbital theory, stereoechemistry, conformational analysis, stereo- and/or regiochemical course. The second module will cover organometallic reactions employed in organic synthesis will be discussed in common transition metal mediated organometallic reactions most commonly employed in organic synthesis will be discussed including their substrate scope, mechanism, and stereo- and/or regiochemical course. Emphasis will be placed on the practical aspects such as catalyst and reaction condition selection, and protocols for trouble shooting catalytic cycles. (Spring, 1st half semester).

437. Syn Design: Strateg and Tactics
Prerequisite: One year of organic chemistry or equivalent; one semester of undergraduate biochemistry or biology recommended (Now CHM 440)

An introduction to bioorganic chemistry and chemical biology. The course will present a survey of how the principles of organic chemistry have been applied to understand and exploit biological phenomena and address fundamental questions in life sciences. The course is primarily based upon the primary literature. Covered topics include the design and mechanism of enzyme mimics and small molecule catalysts (organocatalysts), synthesis and chemical modification of biomolecules (oligonucleotides, proteins, oligosaccharides), design and application of oligonucleotide and peptide mimetics, and chemical approaches to proteomic and genetic analyses. Not open to freshmen and sophomores.

438. Ap Organomet Chm to Synth II
Prerequisite: CHM 421. CHM 436 is recommended but not required.

Applications of Organometallic Chemistry to Synthesis II (2 credits)

The second of two modules where transition metal mediated organometallic reactions employed in organic synthesis will be discussed including their substrate scope, mechanism, and stereo- and/or regiochemical course. The second module will cover a broad range of organometallic reactions. Large-scale those mediated by titanium, zirconium, iron, cobalt, palladium, rhodium, ruthenium, silver, and gold (Spring, 2nd half of semester).

440. Bio Organic Chemistry
Prerequisite: One year of organic chemistry or equivalent; one semester of undergraduate biochemistry or biology recommended (formerly CHM 437)

An introduction to bioorganic chemistry and chemical biology. The course will present a survey of how the principles of organic chemistry have been applied to understand and exploit
biological phenomena and address fundamental questions in life sciences. The course is primarily based upon the primary literature. Covered topics include the design and mechanism of enzyme mimics and small molecule catalysts (organocatalysts), synthesis and chemical modification of biomolecules (oligonucleotides, proteins, oligosaccharides), design and application of oligonucleotide and peptide mimetics, and chemical approaches to proteomic and genetic analyses. Not open to freshmen and sophomores. (Spring)

441. Physical Chemistry I
Prerequisites: PHY 113 and 114 or PHY 121, 122 and 123; MTH 163 or 165, or equivalents

This course is an introduction to quantum mechanics with applications to spectroscopy and to atomic and molecular structure. There are weekly problem sets. Students also participate in workshops each week. Cross listed with CHM 251. (Fall).

444. Advanced Nuclear Science Educational Laboratory (Ansel)
Prerequisites: Physics 123 or 143 - not open to freshmen or sophomores - cross listed with PHY 245 and CHM 244W (formerly CHM 245W/445W)

Students enrolled in ANSEL will develop a sophisticated understanding of our terrestrial radiation environment and of some of the important applications of nuclear science and technology. They will acquire practical skills in the routine use of radiation detectors, monitors, and electronics, and develop the ability to assess radiation threats and prospects of their abatement. The four in-depth ANSEL experiments are designed to help recreate a type of well-rounded, competent experimental nuclear scientist who is able to analyze an experimental problem, to select, design, and set up appropriate nuclear instrumentation, and to conduct required measurements. Laboratory sessions will meet twice a week for two hours and 40 minutes. In addition to the laboratory component of ANSEL, students will attend a weekly lecture (one hour and 15 minutes per week) and lab lecture (50 minutes) to discuss the scientific background of the experiments and to relate principles of radiation detection and measurement. (Formerly CHM 445W) (Spring)

444W. Advanced Nuclear Science Educational Laboratory (Ansel)
Prerequisites: Physics 123 or 143 - not open to freshmen or sophomores - cross listed with PHY 245 and CHM 244W (formerly CHM 245W/445W)

Students enrolled in ANSEL will develop an understanding of our terrestrial radiation environment and some of the important applications of nuclear science and technology. Practical skills in the routine use of radiation detectors, monitors, and electronics. Develop the ability to assess radiation threats and prospects of their abatement. Four in-depth experiments are designed to help create a type of well-rounded, competent experimental nuclear scientist who is able to analyze an experimental problem, select, design, and set up appropriate nuclear instrumentation, and to conduct required measurements. Lab sessions will meet twice a week for two hours and 40 minutes. In addition to the lab component, students will attend a weekly lecture (50 minutes) to discuss the scientific background of the experiments and to relate principles of radiation detection and measurement to modern applications in physics, chemistry, environmental studies, power technology, medicine and forensics. (Spring, formerly CHM 245W).

445W. Advanced Nuclear Science Educational Laboratory (Ansel)
Prerequisites: Physics 123 or 143 - not open to freshmen or sophomores - cross listed with PHY 245 and CHM 244W (formerly CHM 245W/445W)

Students enrolled in ANSEL will develop a sophisticated understanding of our terrestrial radiation environment and some of the important applications of nuclear science and technology. They will acquire practical skills in the routine use of radiation detectors, monitors, and electronics, and develop the ability to assess radiation threats and prospects of their abatement. The four in-depth ANSEL experiments are designed to help recreate a type of well-rounded, competent experimental nuclear scientist who is able to analyze an experimental problem, to select, design, and set up appropriate nuclear instrumentation, and to conduct required measurements. Laboratory sessions will meet twice a week for two hours and 40 minutes. In addition to the laboratory component of ANSEL, students will attend a weekly lecture (one hour and 15 minutes per week) and lab lecture (50 minutes) to discuss the scientific background of the experiments and to relate principles of radiation detection and measurement.

451. Quantum Chemistry I
Prerequisites: CHM 251 and CHM 252 or equivalent

Basic quantum chemistry, Schrödinger equation, basic postulates of quantum mechanics, angular momentum, perturbation theory, and molecular structure. (Fall).

452. Quantum Chemistry II
Prerequisite: Quantum Chemistry I

The goal of this course is to give you sufficient background and familiarity with the basic concepts of Quantum Mechanics as it is applied in Chemistry. While CHM 451 focused on relatively simple exactly solvable problems that let you build the foundations of quantum chemistry, CHM 452 will deal with chemical spectroscopy and approximate methods that are applicable to generic chemical systems.

455. Thermodynamics & Statistical Mechanics
Prerequisites: One year of physical chemistry (CHM 251 & CHM 252), or equivalent.

The course draws connections between the orderly and chaotic behavior of simple and complex systems, laying the foundations of statistical equilibrium and equilibrium thermodynamics. The different phases of matter (gases, liquids, solid) assumed by bulk classical interacting particles and their transitions are discussed in this approximation. Properties of non-interacting quantal
systems are expressed in terms of partition functions, for gases of simple and complex particles. Non-equilibrium statistical behavior of multi-particle systems leads to diffusion and other transport phenomena. Reading assignments and homework. Two weekly lectures of 75 minutes. Cross listed with CHE 455. (Fall)

456. Chemical Bonds: From Molecules to Materials
Prerequisite: CHM 251 or an equivalent course on introductory quantum mechanics
An introduction to the electronic structure of extended materials systems from both a chemical bonding and a condensed matter physics perspective. The course will discuss materials of all length scales from individual molecules to macroscopic three-dimensional crystals, but will focus on zero, one, and two dimensional inorganic materials at the nanometer scale. Specific topics include semiconductor nanocrystals, quantum wires, carbon nanotubes, and conjugated polymers. Two weekly lectures of 75 minutes each. Cross listed with OPT 429. (Spring).

457. Chm Bonds: from Molecules to Mat

458. Spectroscopy and Kinetics
Prerequisite: CHM 451 or equivalent
This course covers the basic theory and experimental practice of spectroscopy in molecules and condensed matter. A general review of electromagnetic waves is followed by classical and quantum mechanical descriptions of the interaction between light and matter. These basic principles are then applied to vibrational and electronic spectroscopy. This course will also cover the principles of kinetic analysis in the context of time-resolved spectroscopies used to quantify the dynamics of photoexcited species. We will refer to examples from the literature to illustrate the experimental implementation and interpretation of advanced spectroscopic techniques. (Fall)

460. Chemical Kinetics
Prerequisite: CHM 451
2 credits
Within the broad area of chemical kinetics, this course will focus on basic concepts of kinetics, photochemistry and electron-transfer (eT). In addition to studying bulk reaction rates, we will discuss Marcus's theory of eT, intramolecular vibrational energy redistribution (IVR) and vibrational cooling, and the fates of photoexcited species (radiative and non-radiative decay channels). We will address the experimental quantification of these kinetics using time-resolved spectroscopy and analysis of kinetic data. The course material will be somewhat continuous with that of CHM 458, Molecular Spectroscopy. (Spring, 2nd half of semester.)

462. Biological Chemistry
Prerequisite: Minimum of one semester organic chemistry required
An introduction to the chemical processes of life. Topics to be covered include proteins and nucleic acids, recombinant DNA technology, biological catalysis, and energy transduction. Structure and function of biological macromolecules will be emphasized. Cross listed with CHM 262. Students will not receive credit for BIO 250 AND CHM 262/462. (Spring).

465. Nuclear Science & Technology I
Prerequisites: Familiarity with Mechanics, Quantum Mechanics
Nuclear technologies of measurement, accelerators and radiation detection, effects and applications of radiation. Fundamental particles interactions, quark model. Nuclear masses, sizes, and shapes. Overview of microscopic and macroscopic models of the nucleus. Nuclear radioactivity and decay modes. Introduction to nuclear reaction theory, classical potential scattering, semi-classical and quantal models of scattering, nuclear excitation, and mass transfer. Mathcad computer projects. Two 75 minute lectures per week, home work problems, and computer simulations. Formerly CHM 466. (Fall).

466. Nuclear Science & Technology I
Prerequisites: Familiarity with Mechanics, Quantum Mechanics (Formerly CHM 466)
Nuclear technologies of measurement, accelerators and radiation detection, effects and applications of radiation. Fundamental particles interactions, quark model. Nuclear masses, sizes, and shapes. Overview of microscopic and macroscopic models of the nucleus. Nuclear radioactivity and decay modes. Introduction to nuclear reaction theory, classical potential scattering, semi-classical and quantal models of scattering, nuclear excitation, and mass transfer. Mathcad computer projects. Two 75 minute lectures per week, home work problems, and computer simulations.

466W. The Adv Nuclear Sci Edu Lab

469. Computational Chemistry I: Classical Molecular Dynamics
Prerequisite: CHM 252 (Statistical Mechanics) or equivalent
In this course students will learn about a range of computational methods that is relevant to their research problems in chemistry. Emphasis will be placed both on the theory underlying computational techniques and on their practical applications. Topics will include molecular mechanics, molecular dynamics and Monte Carlo simulations, methods for free-energy calculations. (Spring)

470. Computational Chemistry II: Electronic Structure Theory and Quantum Dynamics
Prerequisite: CHM 251 (Quantum Mechanics) or equivalent
In this course students will learn about a range of computational methods that is relevant to their research problems in chemistry. Emphasis will be placed both on the theory underlying computational techniques and on their practical applications. Topics will include ab-initio electronic structure theory, density functional theory, path-integral dynamics and non-adiabatic dynamics. (Spring)

475. The Chemistry of Poisons
566. Nuclear Science & Tech II  
Prerequisites: CHM465/PHY 446 Nuclear Science and Technology I  
The course covers a limited number of specific topics in nuclear science and technology, but in more in depth than the introductory course (NST I). A sample set of theoretical and applied topics discussed in the course contains 1. Theoretical models of direct reactions, 2. Nuclear astrophysics in observation and simulation, 3. Statistical model predictions for stability and disintegration modes of excited nuclei, 4. Computational nuclear science. Several modern nuclear science textbooks and additional compilations of relevant science are used as reference and guidance. Assignments include regular homework problem sets and generation/modification of simulation computer codes. One meeting per week. (Offered in Spring - Odd Years)  

583. Adv Chemistry Sem & Colloquium  
585. 1st Yr Graduate Workshop  
591. PhD Readings in Chemistry  
593. Special Topics in Chemistry  
594. Internship  
595. PhD Research in Chemistry  
595A. PhD Research in Absentia  
890. Summer in Residence - MA  
895. Cont of Master’s Enrollment  
897. Master’s Dissertation  
899. Master’s Dissertation  
985. Leave of Absence  
986V. Full Time Visiting Student  
990. Summer in Residence  
995. Cont of Doctoral Enrollment  
997. Doctoral Dissertation  
997A. Doct Dissertatn in Absentia  
999. Doctoral Dissertation  
999A. Doct Dissertatn in Absentia
Clinical and Social Sciences in Psychology

Professors Davies, Deci, Elliot, Reis, Ryan, Smetana, Toth, Zuckerman
Associate Professors Bennetto (Chair), Jamieson, Rogge, Sturge-Apple
Assistant Professors Dodell-Feder, Elenbaas, Glenn, Starr
Joint Appointments: Professors T. O’Connor, T. Smith; Associate Professor Rogosch; Assistant Professors C. Petrenko, Todd-Manly

The Department of Clinical and Social Sciences in Psychology offers programs of study leading to the PhD degree in three areas of psychology: clinical psychology, social-personality psychology, and developmental psychology. An interdisciplinary program in human motivation cuts across the clinical and social-personality areas. Students interested in this interdisciplinary area should apply to the clinical, developmental, or social-personality program, and note in their application their strong interest in motivation. The doctoral program requires a minimum of four years of study. The master’s degree can be obtained en route to the PhD by passing the qualifying examination for the PhD. However, students seeking only the master’s degree are not admitted.

Although each area program is flexible, all programs are designed to prepare students to do research. Upon entering the department, students are appointed a faculty member to advise them on selection of courses and to provide an introduction to research opportunities. Satisfactory progress through the program depends on completion of both coursework and research requirements. Coursework seeks to provide the broad base of knowledge needed for research, including courses outside the students’ areas of specialization. Although the department places strong emphasis on research training, we believe that students should also have teaching experience. All students, therefore, assist in the teaching of at least one undergraduate course (e.g., leading a discussion section, conducting individual tutorials, or assisting in laboratory classes). At the end of their third year, students take the PhD qualifying examination. Passing this exam establishes that the students have a comprehensive grasp of fundamental knowledge in their major areas, and are prepared to undertake dissertation research.

The program in clinical psychology has been accredited continuously since 1948 by the American Psychological Association (Office of Program Consultation and Accreditation, American Psychological Association, 750 First Street, NE, Washington, DC 20002; phone: (202) 336-5979; website: www.apa.org/ed/accreditation). Two additional research units are affiliated with the department: the Mt. Hope Family Center and the Children’s Institute. The Mt. Hope Family Center provides opportunities for training and research in developmental psychopathology. The Children’s Institute provides similar opportunities for work on the detection and prevention of young children’s adjustment problems.

Graduate students in the clinical psychology program receive training in both general and clinical psychology. A sequence of courses provides training in psychometrics, individual differences, psychopathology, cognitive bases of behavior, social bases of behavior, biological bases of behavior, scientific and professional ethics, cultural and ethnic diversity, history and systems of psychology, research design, methodology, and statistics. In addition, graduate students in the clinical psychology program must complete an internship, which may begin only after the second year of residency and satisfactory completion of major comprehensive examinations. The internship must consist of a minimum of 1,750 hours in either a block or distributed format at an agency or combination of agencies approved by the department. During the internship the student’s training should span a variety of clinical approaches and populations. Students are strongly encouraged to complete their internship training in an APA-accredited agency.

The social-personality psychology program provides training for both laboratory and field research. Among the research topics currently featured are achievement motivation, self-determination, social cognition, social interaction, interpersonal processes in close relationships, social psychology of health, and emotion. Innovative research and quantitative methods are emphasized. During their first year, students take courses in general social-personality psychology, research methods, and quantitative methods. Students then take more advanced seminars in social-personality psychology and other areas of psychology while receiving training in a variety of advanced methodological and quantitative skills. In the third year, students take a comprehensive exam in social-personality psychology before starting their dissertation research.

The developmental psychology program prepares students for careers in research and teaching and provides students with the theoretical perspectives and methodological skills needed for advanced scholarly work. Topics currently being researched include emotion recognition, interparental processes and their effects on children, child and family steps to enhance school preparedness and success, moral development, adolescent-parent relationships, neurocognitive processes in developmental disabilities, development of romantic relationships, and the development and maintenance of resilient outcomes among high-risk children. Opportunities for research are also available through involvement at the Mt. Hope Family Center and the Children’s Institute.

The program in human motivation includes faculty and students from social-personality and clinical psychology. It has two major foci. The first is concerned with the nature and development of self-determination, the regulation of behavior, and the internalization of values and goals. Participants working with this focus conduct basic research in the laboratory, as well as field research in areas such as health care, education, and organizations. The second focus is on achievement motivation, using a goals and approach-avoidance perspective. This work also involves both laboratory and field research, particularly in education.

We encourage students to have broad interests, including ones that cross several areas or departments. We maintain strong ties with other biological and social disciplines across the
University, including academic units in the University’s Medical Center, Arts, Sciences & Engineering, and the Margaret Warner Graduate School of Education and Human Development.

To excel in any discipline, students need outstanding facilities, distinguished faculty, and an environment promoting their full integration in the research endeavor. Our department combines all these characteristics.

The department supports students through fellowships, traineeships, and teaching and research assistantships. Teaching and research assistantships typically call for 15 to 20 hours a week under faculty supervision.

Interested students can find all pertinent information describing graduate study in clinical, social-personality, and developmental psychology in the graduate section of the departmental website: www.sas.rochester.edu/psy/graduate/index.html. However, if after reviewing this information you have specific questions about the program, please contact our Academic Coordinator (see website).

The department’s undergraduate and graduate courses are listed below. Although courses with 200 and 300 numbers are primarily for undergraduates, they can be approved for three hours of graduate credit by the student’s advisor.

464. Achievement & Motivation
465. Competence & Mot:dev Countries
491. Master’s Readings
493. Master’s Special Topics
495. Master’s Research

501. Ethical Issues in Clinical Psychology
Psychologists have multiple sets of responsibility with information, and these are defined in this course. Individuals’ rights to privacy underlie ethical principles of confidentiality and the legal concept of privileged communication; informed consent requires that disclosure to a psychologist occur in circumstances that are regulated and mutually understood. Under specific situations, defined ethically or legally, information may or must be shared with others. Through readings and discussion the course examines the ethical, professional, and legal principles that govern the use of information in practice, teaching, and research in psychology. (Fall)

502. Cognitive Fndns of Behavior
Knowledge of cognitive science, theories of learning, memory, and factors that influence an individual’s cognitive performance. Current theories and research in classical and operant conditioning, learning, memory and attention, psychophysics, masking, signal detection theory, language, issues, and emerging methodologies in cognitive science. (Fall)

504. Data Analysis I
Issues of data analysis in experimental research. The course focuses on parametric techniques, specifically analysis of variance. Topics covered include simple and complex designs for between and within subjects factors, including mixed designs; analysis of covariance and trend and contrasts. The course includes a lab in which students are taught to use a popular statistical package for data analysis (Fall)

510. Research Methods in Social-Personality Psychology
This course covers basic principles of research design, operation, and interpretation in social-personality psychology. Topics include experimentation, validity, research design, quantitative methods, and ethics, as well as specific kinds of research designs. The emphasis will be on proper interpretation of existing research and the design of new research.

515. Hierarchical Linear Modeling
516. Structural Equatn Modeling I
517. Structural Equation Model II
This course will build upon methods covered in Structural Equation Modeling I by covering advanced topics in SEM including advanced applications for growth modeling, categorical latent variable (mixture) modeling in cross-sectional and longitudinal modeling settings, and growth mixture-modeling.

519. Data Analysis:gen LIN App 11
520. Psychology of Religion
551. Social Cognition
552. Human Motivation & Emotion
The course focuses on the current field of human motivation and emotion, reviewing various theories and research programs, and covering related work in personality, cognition, learning, and performance, including operant and drive theories.

553. Seminar in Social Psychology
An advanced overview of the field. Attitudes, interpersonal influence, attraction, aggression, social comparison, leadership, prejudice, and methodology

555. Close Relationships
557. Affective Bases of Behavior
560. Fam Processes in Childhood
561. Top in Social Psy Research
CSP 561 fulfills two objectives. The class is the venue for Social/Personality graduate students to fulfill the formal research project requirement outlined in the CSP Handbook (more commonly known as the Two-Year Project). The class is also a forum for graduate students to meet regularly to discuss research issues and professional matters.

562. Fam Processes in Childhood
563. Adolescent Development
565. Early Child Development
566. Neurobiological Foundations of Behavior
567. History & Systems
568. Psychology of Health
The seminar will be a review of psychological factors related to health and well-being. Such factors might include social support, money, discrimination, stress, compassion and forgiving, self-esteem, etc. We will also discuss the nature of happiness and well-being.

569. Developmental Theory & Research
570. Clinical Assessment I
571. Clinical Assessment II
572. Introduction to Clinical Research Methods
573. Culture & Diversity Awareness
574. History & Systems of Psychology & Psychotherapy
575. Psychopathology I
Examines psychopathology of childhood and adulthood from a developmental perspective that encompasses the study of both normal and abnormal development. Topics covered include: taxonomic, definitional, and epidemiological issues; mental retardation; autism; child maltreatment; affective disorders; schizophrenia; resilience; and ethical considerations in conducting research.

576. Psychopathology II
582. Practicum in Developmental Psychopathology
583. Moral Development
584. Psychotherapy Practicum I
585. Psychotherapy Practicum II
586. Evidence-Based Child Psychopathology
587. Social Psychophysiology
595. PhD Research
595A. PhD Research in Absentia
598. Seminar in Teaching
897. Master’s Dissertation
899. Master’s Dissertation
985. Leave of Absence
986V. Full Time Visiting Student
987V. Part-Time Visiting Student
995. Cont of Doctoral Enrollment
997. Doctoral Dissertation
997A. Doctoral Dissertation in Absentia
999. Doctoral Dissertation
999A. Doctoral Dissertation in Absentia
999B. PhD in-Absentia Abroad
Earth and Environmental Sciences

Professors Garzione, Mitra, Poreda, Tarduno (Chair)
Associate Professors Kessler, Petrenko
Assistant Professors Ibanez-Mejia, Murray, Nakajima, Olugboji, Trail, Weber

The department offers programs of study leading to a PhD in geosciences and an MS in geological sciences. These programs provide classroom, laboratory, computing facility, and field instruction as well as research experience to prepare students for successful careers in academia and industry. The department faculty conduct active research in paleomagnetism, seismology, geodynamics, solid earth geochemistry, noble gas geochemistry, cosmogenic isotope geochemistry, light stable isotope geochemistry, environmental geochemistry, geochronology, sedimentary geology, stratigraphy, structural geology, tectonics, atmospheric chemistry and climate, paleoclimate and atmospheric chemistry, and oceanography. Information on this research can be found at the department’s website: www.ecs.rochester.edu.

Graduate research is facilitated by a number of state-of-the-art laboratories that complement active field-based research programs. The department has several mass spectrometers that support research in geochemistry, tectonics, and sedimentology. These instruments include a Thermo Electron Delta Plus XP IRMS and an Agilent 7900 ICP-MS, used to determine the trace metal content and isotopic composition of geological, environmental, and biological materials.

Research in paleomagnetism and rock magnetism, currently devoted to understanding the history of dynamos and their role in planetary habitability, is carried out in the paleomagnetic laboratories, which feature a model 755 2G DC SQUID Superconducting Rock Magnetometer and a unique ultra-sensitive small bore 2G DC SQUID Superconducting Rock Magnetometer devoted to single crystal studies; the latter is currently the most sensitive 3-component rock magnetometer. The Cryogenic magnetometers and a CO2 laser demagnetization system are housed in a magnetically shielded room. Other key equipment includes a Princeton Measurements 2900 Alternating Gradient Force Magnetometer, a GeoFyzika JR-5A high-speed automatic spinner magnetometer, and an AGICO KLY-4 Kappabridge. Data are analyzed using Unix workstations.

Equipment in the structural geology laboratory includes Olympus and Nikon research microscopes (set up for photomicrography and semi-automated point counting), Leitz microscope and Universal Stage for fabric studies, Technosyn cold-cathode luminescope, Numonics digitizer, and IBM PC and Mac computers with various structural and graphics software.

The ice core laboratory stores and analyzes samples of ancient ice from Greenland and Antarctica (as old as 50,000 years) and has the world’s largest system for extracting ancient air out of glacial ice. The lab houses a state-of-the-art isotope ratio mass spectrometer, systems for extracting carbon monoxide and carbon dioxide from ice and for extracting methane from air samples, a gas chromatograph for analyses of carbon monoxide and hydrogen, and a laser instrument for analyses of carbon dioxide, methane, and water vapor.

A laboratory studying ocean biogeochemistry exists in the department that specializes in the investigation of marine carbon dioxide and methane dynamics. The laboratory contains three commercially available and one homegrown cavity-ring-down spectrometers for the analysis of carbon dioxide, carbon monoxide, methane, and dissolved inorganic carbon concentrations and stable isotopes. This lab contains a gas chromatograph with a flame ionization detector for the quantification of C1-C5 hydrocarbons in seawater and sediment. All of this equipment is used in the laboratory as well as in the field on research vessels.

The experimental geochemistry laboratory is the newest addition. The laboratory contains specialized high-pressure/high-temperature equipment capable of achieving pressures of up to four gigapascals (equivalent to 120 km depth within the Earth) and temperatures of up to 2000°C. The goal of these experiments is to help explain the evolution of planets and moons through time, including the first 500 million years of Earth history. A Photon Machines’ 193 nm excimer laser coupled to an Agilent 7900 quadrupole mass spectrometer (LA-ICP-MS) is the analytical centerpiece of the laboratory.

The new isotope geochemistry and geochronology laboratories include a Class 1000 clean room for the isolation of trace metals from rock and mineral samples at low contamination levels; the room is equipped with four Class 10 vertical laminar flow workstations and sub-boiling distillation assemblies for the preparation of ultra-pure reagents. Along with additional heavy-mineral separation equipment, binocular microscopes for mineral picking and imaging, and a cathodoluminescence detector, the lab has the capabilities to process and image geologic samples for conducting high-precision and high-resolution geochronologic and isotopic analyses.

The Biogeochemical Oceanography Group uses numerical models to explore the interactions between marine ecosystems, elemental cycling, and the global climate system. Current research focuses on the oceanic cycling of trace metal micronutrients, and the dynamics of sinking organic particles that transfer carbon to the ocean interior.

The atmospheric chemistry and climate computational laboratory has high-performance computing facilities dedicated to the development and application of cutting-edge models that resolve the spatial and temporal evolution of mass and energy in Earth’s atmosphere. Research examines the intersectionality of air quality, climate change, and biogeochemical cycles across geological and human time scales. Forward and inverse modeling techniques are interpreted using satellite and other big-data observations.
Graduate students are expected to have a strong background in geoscience and broad knowledge of other sciences and mathematics. However, because of the interdisciplinary nature of research in the department, applications are also welcome from students with strong backgrounds in particular areas of science (especially chemistry, biology, physics, engineering, and materials science) even with only a modest background in geoscience. Financial aid is available in the form of teaching and research assistantships and fellowships. Applications from qualified women and minorities are strongly encouraged.

The department offers a five-year BS/MS program for highly qualified University of Rochester undergraduates. Students should apply to the program early (ideally during the fall of their junior year in order to fulfill all requirements in a timely manner. MS students are expected to spend most of their fifth year in research. All graduate students are expected to take a combination of courses designed to provide an in-depth understanding of their area of specialization, as well as a general expertise in geological sciences. This curricular program is designed individually for each student, in consultation with the student’s research advisor and thesis committee, and consists primarily of 400-level courses. These courses generally carry four hours of graduate credit each. A limited number of 200- and 300-level courses may be taken with special permission to make up for a deficiency or to develop a new area of interest. All curricular programs must be approved in advance by the department’s Graduate Studies Coordinator. To ensure that candidates for the MS and PhD obtain experience as teachers, all students are required to aid in instruction for at least one term.

405. Solid Earth Geophysics

406. Petrology & Geochemistry
Prerequisite: EES 101

Distribution, description, classification, and origin of igneous and metamorphic rocks in the light of theoretical-experimental multicomponent phase equilibria studies; use of trace elements and isotopes as tracers in rock genesis; hand specimen and microscopic examinations of the major rock types in the laboratory. (Spring)

407. Adv Sem Climate & Env Chng
Prerequisites: At least 1 of EES 212, EES 218 or EES 265

This seminar will focus on the IPCC 2013 Working Group I report (Physical Science Basis). The IPCC stands for Intergovernmental Panel on Climate Change and is the main international organization for assessing the current state of scientific knowledge for global climate change. The IPCC reports are a result of contributions from thousands of scientists from all over the world, and are a comprehensive summary of the current state of climate change research. The course will be conducted in a reading-and-discussion format. Students will be expected to lead some of the discussions as well as actively participate in all of the discussions (Fall).

Prerequisites: MTH 161 and CHM 131

Most introductory courses to chemical oceanography cover a variety of topics that are only related because they are under the broad umbrella of chemical oceanography. Some of these topics include the carbon dioxide and inorganic carbon chemistry, salinity, marine nutrients, dissolved gases and organic constituents. Similarly, most discussions of climate change and chemical oceanography only touch on ocean acidification. This course seeks to provide the same broad prospective to conventional chemical oceanography courses but will interweave the unifying theme of climate change into these numerous and diverse topics. (Fall)

412W. Res Ocean Biogeochem I

413. Research Biogeochem II

413W. Res Ocean Biogeochem II

416. Environmental Geochemistry

417. Chemical and Isotope Hydrology
Prerequisite: EES 101

This course provides a foundation in both qualitative and quantitative analyses of the dynamic interaction between water and geologic media. The first part of the course outlines the formation of water, atmospheric processes, and the hydrologic cycle. The second part focuses on the theory of, and geologic controls on, groundwater flow. The third and final part of the course deals with natural groundwater geochemistry and environmental contamination. (Spring)

418. Atmospheric Geochemistry
Prerequisites: EES 101, CHM 131-132, MTH 141-142, MTH 163 useful but not required

The atmosphere helps to maintain habitable temperatures on our planet’s surface, shields life from destructive cosmic and ultraviolet radiation and contains gases such as oxygen and carbon dioxide, which are essential for life. In this course we will use lectures, discussions and hands-on activities to work toward an understanding of several important questions. How did the Earth acquire and atmosphere? What is in the Earth’s atmosphere? What are the sources and sinks of the most important gases in the atmosphere? What is the role of photochemistry in atmospheric composition? How does the atmosphere interact with the land and oceans? How has human activity affected the atmosphere? (Spring)

420. Introduction to Geobiology

Geobiology is the study of the interactions between the biosphere (living organisms and their products) and the geosphere (atmosphere, hydrosphere, lithosphere, cryosphere). This class will explore how the chemical and physical processes of the geosphere...
have influenced life and evolution and how life has influenced the Earth system during the roughly 4 billion years since life first appeared. Several topics will be particularly emphasized, such as the microbial weathering of minerals, bacterial and skeletal biomineralization, the roles of autotrophic and heterotrophic metabolisms in elemental cycling, the redox history in the oceans and its relationship to evolution and the origin of life itself. (Spring)

422. Energy Resources

430. Principles of Geochronometry

431. Ice Sheets, glaciers, clim Chng
Prerequisites: EES 101 or 103 or 105 (or equivalent), MTH 161-162 (or equivalent)
The flow of glacier ice and climate-ice interactions affect the state of the cryosphere and impact critical aspects of the Earth system. Our understanding of present and past behavior of glaciers and ice sheets is key to anticipating likely future change in global sea level. We will explore fundamental glaciological processes and work to understand the current state of mountain glaciers, ice caps, and the polar ice sheets through a mix of lectures, current and classic readings from the literature, and in-class discussions. This seminar course is appropriate for advanced undergraduates (EES 231) as well as graduate students (EES 431). (Fall)

432. Seminar in Marine Biogeochm
The "biological pump" is the suite of biogeochemical processes that lead to carbon sequestration in the deep ocean, out of contact with the atmosphere, and is an important regulator of global climate. This seminar will review the seminal works that have sought to understand and quantify the component processes: 1) the production of organic carbon by photosynthetic plankton in the sunlit surface ocean; 2) aggregation of organic matter into sinking particles; 3) degradation of those particles over depth. We will then review evidence for the changing strength of the biological pump over Earth's history, and the attempts to predict its response to current climate warming. (Fall)

433. Marine Ecosys & Carbn Cyc Mod
Prerequisite: No prior computing experience required; an extensive grounding will be provided in the MATLAB programming language that will be used throughout the course.

Over the last few decades, numerical biogeochemical models have provided new insights into the marine carbon cycle, its contribution to past climate change, and its potential responses to future climate warming. In this practical class, students will build simple biogeochemical models ranging from "box" models of marine microbial ecosystems to three-dimensional nutrient cycling models and design experiments to address climate change hypotheses. They will also be taught to analyze output from state-of-the-art climate models used by the Intergovernmental Panel on Climate Change. Students will not only learn invaluable programming skills, but also gain a deeper intuition of the ocean carbon cycling and its role in the global climate system. (Spring)

434. Fund. Atmospheric Modeling
Prerequisite: EES 105 or EES 218 or equivalent; MTH 165 or equivalent; CHM 131-132 or equivalent; PHY 121 or equivalent; or permission of instructor. PHY 255 or equivalent recommended but not required.

Global atmospheric models are critical research and policy tools used to understand and predict the weather, climate change, and air pollution. This course provides an applied introduction to the physics, chemistry, and numerical methods underlying simulations of the spatial and temporal evolution of mass, energy, and momentum in planetary atmospheres. Topics include: finite-differencing the equations of atmospheric dynamics, radiative transfer models, numerical methods for solving systems of chemical ordinary differential equations, parameterization of small-scale processes, surface exchanges, inverse modeling, and model evaluation techniques. Assignments focus on the implementation and application of simple models by students; no prior experience with scientific programming will be assumed. Students will also gain experience using state-of-the-science models of atmospheric chemistry and/or climate in a final project of their choosing. (Spring)

435. Physical Oceanography

436. Physics of Climate

445. Solid Earth Geochemistry
Composition, structure and evolution of the Earth over the past 4.5 billion years; isotopic geochemistry of crust-mantle processes; phase transitions within the Earth and their tectonic significance.

447. Chem. Evolution of the Earth
Prerequisites: General knowledge of Mineralogy and Petrology. EES 206-Petrology required for undergraduates

We will discuss the main geochemical characteristics of the major reservoirs that comprise the solid Earth, the processes by which they formed and evolved, and the analytical tools used for their study. We will cover topics of high-temperature geochemistry, extinct radionuclides, and radiogenic and stable isotope geochemistry. Emphasis will be placed on the formation of Earth’s continental crust. This course is cross-listed with EES 447. (Spring)

448. High Temperature Geochemistry
Prerequisites: EES 101, CHM 103

An introduction to the principles of geochemistry. The first portion of the course is devoted to basics, especially thermodynamics, and isotope (both stable and radiogenic) geochemistry. The middle portion of the course deals with high temperature processes and crystallization. The last part of the course covers lower temperature processes including weathering, sediment diagenesis and element cycling through the lithosphere. (Spring)
450. Seminar in Geodesy  
Prerequisites: PHY 114/122 and MTH 162 (MTH 165 recommended)  
This course introduces students to theory and methods in geodesy. Topics include geoid and gravity field derivation and products, space-based geodetic methods, and their use in crustal deformation and mantle dynamics studies. (Fall)

452. Marine Geology

453. Geodynamics

455. Planetary Sci-Geol Evolutn

456. Paleomag/Global Plate Tech

457. Seismic Reflection Analyses and Interpretation  
Prerequisite: PHY 121 or equivalent required; EES 205 or 215 recommended  
Geothermal, groundwater and petroleum exploration and extraction rely on subsurface information. 2D and 3D seismic reflection methods are a foundation in many basin regions, as well as crustal studies. Students will review data acquisition and processing methods to understand limitations and potential artifacts in seismic reflection data sets. A major component of the class is a problem-solving project involving seismic reflection data and calibrations with well, rock outcrop and other data. Students will work independently and in teams. (Spring)

458. Hotspots & Plate Motions  
Prerequisite: EES 101 or equivalent or permission of instructor  
This course will provide a basic understanding of hotspot models, hotspot fixity and the relationships between hotspots, mantle plumes, true polar wander and plate motions. Hypothesis development and testing will be discussed, as will the basic elements of grantsmanship. (Fall)

459. Seminar in Paleomagnetism  
Prerequisite: EES 101 or permission of instructor  
Current topics in paleomagnetism and rock magnetism are explored through literature reviews and modeling studies. Topics range from the history of plate tectonics to biogenic magnetism. An introduction to basic concepts in paleomagnetism and rock magnetism is included. (Spring)

460. Seminar-Early Earth Geochem  
This course is about the geochemical and geophysical processes of the earliest Earth. It will explore topics such as the formation of the Moon, the early accretionary history, the origin(s) of life, the nature of the earliest igneous and sedimentary crust, the composition of the atmosphere, and the timing of core formation. Students will learn how to effectively leverage extremely limited geochemical and geophysical constraints in order to support useful conclusions. Before enrolling in this course, students should be comfortable with the basic principles of geochemistry. (Spring)

461. Stable Isotope Geochemistry  
Prerequisites: CHM 131-132 and MTH 161-162  
Most courses in stable isotopes highlight the analytical techniques and classic examples of applications of stable isotopes. However, the stable isotope investigations in this course will stress the fundamentals of stable isotope models, along with their underlying assumptions, guided by several classic applications. Not only will we learn the equations used in these pioneering applications, but we will set-up and derive these equations. The goal of this course is to equip students with the knowledge needed to both dissect and as manipulate traditional stable isotope models so that they can analyze their data in the most appropriate and intelligent fashion. (Spring)

462. Seminar in Noble Gas Geochem  
This course will examine topics in noble gas geochemistry through a series of recent articles on various topics. (Spring)

463. Intro Thermodynamics and Kinetics  
The goal of this course is to provide an overview of the equilibrium and kinetic processes that govern the elemental and isotopic composition of rocks and minerals. The course will be divided into two broadly equal components. In the first part, the fundamentals of thermodynamics, phase diagrams, and selected examples in earth systems will be explored. The second half of the course is devoted to understanding the non-equilibrium case for earth materials; diffusion in minerals and melts is emphasized. Students are expected to have a general knowledge of mineralogy, petrology, and very basic thermodynamics prior to taking the course. (Fall)

464. Paleoenv.reconstructions Using Light Stable Isotopes  
Prerequisites: EES 101 or EES 103 (open to Juniors and Seniors)  
This class will focus on techniques used in environmental reconstruction to address questions related to paleoclimate, paleotemperature, paleovegetation and paleoelevation. We will examine the use of stable isotopes in paleoenvironmental reconstructions with particular emphasis on O,C, and to a lesser extent H and N isotopes. The class will start with a thorough introduction of the geological framework of the environments of interest and the processes of light isotope fractionation. This will be followed by “emphasis areas” that highlight the basics and latest developments in a variety of environmental systems, including the oceans, rivers, ice, lakes, soils and fossils. (Spring)

465. Paleoclimate  
Prerequisites: EES 101 or 103 (or equivalent), MTH 161-162 (or equivalent), CHM 131 (or equivalent)  
The Earth’s climate is changing in a potentially fundamental way because of human activity. In this course we will look into
Earth’s climate history in order to gain a better understanding of how the climate system works and what we can expect from Earth’s climate in the future. During its history, the Earth has gone through periods that were much warmer as well as periods that were much colder than today. By examining the geological record of the environmental conditions, we can gain insights into how key parameters such as greenhouse gas concentrations, insolation and positions of the continents influence the climate system. (Fall)

**466. Ice Core Records of Climate and Environmental Change**  
**Prerequisites:** MTH 161-162 or equivalent, CHM 131 or equivalent, PHY 113 or equivalent, and one of: EES 101, 103 or 105.

This course is intended for graduate students and advanced undergraduates and will provide an introduction to the exciting field of ice core research. We will cover the basics of ice core science in the first few sessions, and then continue with more in-depth sessions on some of the most important and interesting questions in the ice core field. A large component of the course will be reading, presentation and discussion of the research literature. Students will be expected to write either an individual or a group review paper on an ice-core related question of their choice. (Spring)

**467. Isotope Geochemistry**

Causes for differences in the isotopic composition of elements. Nucleosynthesis, fractionation, radioactive decay and cosmogenic production. Evolution of crust and mantle, formation of ore deposits, tracing of fluid movements, history of cosmic ray flux and other applications of stable and unstable isotopic systems to geologic problems. (Fall)

**468. Prin.experimental Geochem**

**469. Sem Earthqu & Volc Deform**

**470. Vertebrate Paleontology**

**474. Paleoceanography & Clim Chg**

**480. Mat Prop of Deformed Rocks**

Elastic, linear and nonlinear viscous and perfectly plastic behavior of rocks. Effect of dislocation and diffusional creep, grain boundary sliding, microfracturing and recrystallization on rocks. Study of microstructures to determine macroscopic flow laws. (Fall)

**481. Microtectonics**

Study of microstructures, fabric and textures in rocks to define deformation patterns, deformation mechanics and flow laws. (Fall)

**483. Sedimentary Basin Analysis**  
**Prerequisites:** The prerequisite for undergraduates is EES 203-Sedimentology and Stratigraphy. There is no prerequisite for graduate students.

We will discuss basin classification schemes, isostasy, flexural and thermal subsidence, effects of mantle dynamics, basin stratigraphy, and techniques used to study sedimentary basin evolution. By determining how sedimentary basins develop and fill, we will better understand the tectonic and eustatic controls on subsidence and surflcial processes. (Fall)

**484. Stress & Strain in Rocks**

**485. Strc & Tectonics of Mont Belts**

**486. Sem in Sedimentology & Tectncs**

**487. Climate and Tectonic Interactions**

This class will focus on current topics on the interactions between climate and tectonics, such as how the growth of large mountain belts has modulated global climate over time and how climate influences the tectonic evolution of mountain belts. The first several weeks of the semester will be focused on an introduction to the region of study and the climate-tectonic processes of interest. The rest of the class will be focused on a review of recent literature. Students will choose a research topic and develop their grant-writing skill through a class-related project. (Fall)

**488. Geometry and Mechanics of Thrust Faults**

Geometry of thrust faults and thrust belts. Mechanics of thrust motion and thrust emplacement. Homework assignments and readings on current literature. Field trip to the Appalachians to look at typical structures of fold-thrust belts. (Spring)

**489. Topics in Adv Struc Geology**

**490. Supervised College Teaching**

**491. Master’s Readings in Geology**

**492. Graduate Field Seminar**

**493. Master’s Essay**

**495. Master’s Research in Geology**

**499. Research Frontiers in Earth Sciences**

**591. PhD Readings in Geology**

**594. PhD Research Internship**

**595. PhD Research in Geology**

**595A. PhD Research in Absentia**
Economics

Professors Alessandria, Bils, Chang, Govindan (Chair), Kocherlakota, Landsburg, Rizzo, Thomson, Wolkoff
Associate Professors Bai, Barelli, Chen, Pavan, Yildiz
Assistant Professors Awaya, C. Caetano, G. Caetano, Kochov, Lu, Park, Singleton, Tan
Joint Appointments: Professors Duggan, Kalandrakis

The Department of Economics offers a graduate education that focuses on developing students’ analytical and research capabilities. The blend of coursework, active seminars, research workshops, and informal faculty-student interactions has met with substantial historical success, demonstrated by the professional achievements of the program’s graduates and, more formally, by placement in the top 10 graduate programs, according to the rankings of effectiveness published by the National Academy of Sciences.

The department’s doctoral program requires at least three years of full-time study. The first two years are principally spent in required coursework, with students typically undertaking two or three additional years of on-campus dissertation research. This PhD training builds upon the opportunities for close working relationships between students and faculty that are possible within a small, integrated program. The aspect of the program is especially important during the thesis-writing phase when students confront the frontiers of economic knowledge.

Each student subsequently develops a field of specialization. The available fields are econometrics, economic history, industrial organization, international economics, labor economics, macroeconomics, microeconomic theory, political economy, and social choice. (For more information about political economy, see W. Allen Wallis Institute of Political Economy.) The student’s preparation is evaluated by a qualifying examination in each field of specialization. A distribution requirement, satisfied by taking a graduate course in two fields other than the fields of specialization, insures breadth of knowledge.

All PhD candidates are required to do some supervised teaching as part of the degree requirements. Ordinarily, students will not teach in the first or second year. Advanced students sometimes have the opportunity to teach a course of their own.

Proficiency in both oral and written English is required. The University’s English as a Second Language Program is available for improving English skills. Further details on the graduate program requirements may be found in the departmental memorandum and the Ph.D. Program in Economics: Requirements and Timetable. This and other current and updated information may also be found on the department’s website at www.econ.rochester.edu.

Credit for courses numbered 400–499 is four hours, except as noted; credit for courses numbered 500–599 is five hours, except as noted.
471. Modern Value Theory I
The foundation of modern microeconomic analysis, including consideration of consumer behavior, the theory of the firm, equilibrium under alternative market structures, and welfare implications.

472. Modern Value Theory
Introduction to non-co-operative game theory, asymmetric information models, and social choice theory

475. Macroeconomics
Reviews the main empirical regularities that characterize economic growth and business fluctuations in market economies. Discusses various theoretical models of the business cycle, as well as the macroeconomic impact of fiscal and monetary policy.

476. Macroeconomics II
This course continues on with the theme developed in 475: understanding modern macroeconomics based on dynamic optimization in a general equilibrium environment. The emphasis is placed on understanding business cycles, economic growth, fiscal and monetary policies. (Spring)

481. Introduction to Math Economics
This course covers the use of optimization theory in economic analysis. The topics covered include finite-dimensional optimization (unconstrained optimization, Lagrange’s Theorem, the Kuhn-Tucker Theorem), the role of convexity in optimization, parametric continuity of solutions to optimization problems, and finite- and infinite-horizon dynamic programming.

482. Math Economics

483. Introduction to Math Statistics
Elements of probability theory and statistics, as employed in the econometrics sequence ECO. Two credit hour class.

484. Introduction to Mathematical Statistics and Econometrics
Prerequisite: ECO 483 or permission of department.
Elements of probability theory and statistics as employed in econometrics. Estimation and inference in the standard linear model. (Fall)

485. Introduction to Econometrics
(Same as APS 515)
Prerequisite: ECO 484

491. Master’s Readings in Econ

493. Master’s Essay

495. Master’s Research in Econ

501. Seminar Labor Economics
Selected topics in labor economics are discussed. The topics vary from year to year. In recent years, topics have included human capital, models of wage growth, inequality, and labor policy.

502. Discrete Choice Models
Selected topics in labor economics are discussed. The topics vary from year to year. In recent years, topics have included human capital models of wage growth, wage inequality, and labor policy.

503. Topics in Labor Economics
The course is a mix between methods and topics. The first half of the course focuses on estimating dynamic discrete choice (DDC) models, a common tool used in structural labor, education, and industrial organization. The second half of the course then examines topics related to the development of human capital, often through the lens of DDC models. The topics typically include human capital related issues in K-12 education, higher education, early childhood investments, and understanding the returns to human capital in the labor market.

504. Topics in Applied Micro

505. Res in Applied Econometrics

507. Economic Theory Workshop

508. Economic Theory Workshop

509. International Trade
Theory of specialization according to comparative advantage. Effects of tariffs on the gains from trade and the distribution of income. Standard and new trade theories.

510. International Economics
Topics in exchange rates, the balance of payments, asset-pricing and international capital flows, macroeconomics of open economies, and monetary systems.

511. International Workshop

512. International Workshop

514. Topics in International Fin
519. Topics in Microeconometrics
Course content varies from year to year. Panel data, cross-section time series, qualitative dependent variables and duration analysis are possible topics discussed.

520. Topics in Macroeconometrics
Prerequisite: ECO 517 or permission of instructor
The course is an introduction to the econometric analysis of time series. ARMA models and nonlinear models for conditional mean dynamics, models for volatility, spectral analysis, linear regression, VAR, unit root processes and co-integration are possible topics discussed.

521. Advanced Economic Theory

522. Topics in Decision Theory
This course studies choice theory with particular emphasis on choice under risk, the distinction between risk and uncertainty, and behavior in dynamic settings. The approach is largely formal and axiomatic, though applications are also considered.

523. Cont Topics in Econometrics

524. Topics in Game Theory

525. Economic Mechanism
Existence and construction of mechanisms with desirable properties, elicitation schemes, implementation of social choice, planning procedures, matching procedures, fair mechanisms, manipulation of mechanisms.

526. Seminar in Game Theory
Topics in dynamic games

529. Macro-Labor
This course covers topics of current research interest in macroeconomics and labor market dynamics.

530. Adv Top in Monetary & Fin Eco
Graduate seminar covering recent research in monetary and financial economics.

531. Macroeconomic Workshop

532. Monetary Workshop

534. Topics in Macroeconomics
This is a doctoral level course in macroeconomics. Topics covered in the course are aggregate implications of financial imperfections. We will review recent papers on the implications of financial imperfections on business cycles, asset prices, government policies, firms and open economy issues. (Fall)

535. Quantitative Macroeconomics
The focus of this course is on studying macroeconomic models with many types of households and firms. Models of capital, labor, financial, and marriage markets are presented. Issues such as adoption of new technologies, the determination of asset prices, marriage and divorce, and unemployment are studied. The development of the mathematical and computational skills required to do state-of-the-research in macroeconomics is stressed.

536. Applied Macroeconomics
The course considers theories of aggregate fluctuations and unemployment in light of a broad set of empirical regularities. (Fall)

547. Econometrics Workshop

548. Econometrics Workshop

551. Applied Economics Workshop

552. Applied Economics Workshop

571. Readings in Macroeconomics
Faculty and Students will go through a series of recent working papers in macroeconomics with emphasis on quantitative and empirical topics.

573. Readings Applied Economics

575. Political Economy I
This course will focus on several foundational topics in theoretical political economy. Within the paradigm of social choice theory, we cover Arrow’s impossibility theorem, the limitations of rational collective decisionmaking, and the consequences for political stability vs. instability. We then take the perspective of noncooperative game theory and cover (among other things) the theory of implementation, strategic voting and the design of nonmanipulable voting rules, and the power of agenda setters.

578. Readings in Intl Economics

582. Political Economy II
The course develops and uses theoretical models with economic and political elements. A range of issues are studied with specific applications varying from year to year.
Professors Bleich, Eaves, Gross, Grotz, Hahn, Higley, London, Longenbach, Michael, Scott
Associate Professors Heyworth, Kegl (Chair), Mannheimer, Middleton, Rajan, Schottenfeld, Tawil, Tucker
Assistant Professors Burges, Miller, Rozenski

The Department of English offers programs of study leading to the degrees PhD or MA.

The program leading to the doctorate emphasizes the critical and scholarly study of English and American literature, as well as cultural studies, critical theory, film, and media studies. It is also concerned with developing the candidate's ability as a classroom teacher. Candidates may enter the doctoral program directly from their undergraduate work or after completion of an MA. The course of study for the PhD degree begins with two years (60 credits) of coursework for students entering with a BA in English or related fields, and a further year (30 credits) of research and preparation for exams. These courses may include independent reading courses designed by the student in consultation with a member of the faculty and approved by the director of graduate study (DGS). Students entering the program with an MA in English may, subject to approval by the DGS, transfer up to 30 graduate credits and thereby shorten their coursework. PhD students are not ordinarily expected to teach in their first two semesters of study, but are expected to devote full time to their coursework. Students in the PhD program will then conduct a teaching apprenticeship under a faculty member in the department in year two; at the end of the second year, they may apply to teach in the College Writing, Speaking, and Argument Program (where, pending their acceptance, they may continue to teach throughout their PhD candidacy). Also by the end of their second year, PhD students select a faculty committee with whom they work to define and prepare areas of specialization for their Qualifying Exams. Students take their Qualifying Exams before the end of their third year. After completing their exams, students must file a prospectus for their doctoral dissertation.

PhD candidates also must achieve an advanced level of fluency for reading literature and scholarship in at least one foreign language, appropriate to their specialization; some areas of specialization may require more than one foreign language. A student's language exam must be passed prior to the Qualifying Exams.

The MA program has been set up so that students may finish within a calendar year. MA candidates work out with the MA advisor a program of 30 credit hours. After finishing coursework, MA students may choose to write an essay or to take a set of comprehensive field examinations; this work is undertaken in consultation with a faculty advisor. There is no foreign language requirement for the MA degree.

The typical plan of study for both PhD and MA candidates consists of some combination of 500-level and 400-level courses. A 500-range course number indicates a traditional graduate seminar—consisting of a maximum of 15 participants (all graduate students) and convening once a week for three hours at a time. The 500-level syllabi are specifically crafted to immerse students...
in a careful mix of both primary and secondary readings; the intellectual focus of a 500-level course often centers as fully on questions of methodology or theory as it does on questions of genre or history.

A 400-range course number also indicates an upper-level course. However, a 400-level course may enroll both graduate students and advanced undergraduates (with the balance frequently, but not always, tipping toward the latter). Accordingly, 400s meet twice per week for 75 minutes each, and their syllabi tend to focus on primary texts; likewise, discussion is geared toward students with a wider range of backgrounds and skills. One strategy that the department has devised in order to bring the 400 experience slightly closer to the 500 experience is to dictate that all graduate students enrolled in a 400 be required to set up an extra credit hour with the instructor. The specific nature of this credit hour is up to the instructor’s discretion but usually includes additional readings, an extra discussion hour, and a longer final paper.

While 500-level courses boast their distinct advantages, the benefit of the 400-level courses is also significant; most importantly, perhaps, 400-level courses enable the department to offer graduate students additional curricular diversity. Thus while the course schedule normally includes only about four or five 500-levels each semester, it contains dozens of 400s —often on topics more specialized than would be found in a 500-level seminar (e.g., courses devoted entirely to the oeuvres of single authors such as Jane Austen, James Joyce, or Ernest Hemingway; a course on Feminist Film Theory; or a course on literary figurations of King Arthur). Students are therefore encouraged to consider 400s when putting together their plans of study (specific titles and descriptions for which are available online). However, such courses should make up no more than half of any graduate student’s total credit hours, and PhD students may enroll in them only by permission of the DGS: the real heart of any graduate-degree candidate’s program of study should inhere in the 500-level seminar.

400. History of the English Lang
The development of the English language from the Anglo Saxon period on up, focusing on texts from representative periods. (Fall Spring)

401. Old English Language & Literature
Literature written in England before the Norman Conquest. Latin works are read in translation; vernacular works, in the original. (Fall Spring)

402. Middle English Literature
Poetry, prose, and drama of the thirteenth, fourteenth, and fifteenth centuries, exclusive of Chaucer. Readings in Middle English. (Fall Spring)

403. Medieval Drama
English drama from its beginnings until 1580, including material from the mystery cycles, moralities, and early Tudor drama. (Fall Spring)

404. Chaucer
The principal works of Chaucer, in their historical and intellectual context. Readings in Middle English. (Fall Spring)

405. Mystical Literature

406. Studies in Medieval Literature
Varying topics relating to the literature and culture of the Middle Ages. (Fall Spring)

407. English Renaissance Literature
Sixteenth-century literature from Sir Thomas More to Spenser, with some attention to the continental background. (Fall Spring)

408. Renaissance Drama
English Renaissance drama through 1642, exclusive of Shakespeare. (Fall Spring)

409. Studies in Shakespeare
Readings of a selection of Shakespeare’s plays. (Fall Spring Summer)

410. Shakespeare
Readings of a selection of Shakespeare’s plays. (Fall Spring)

411. Milton
The works of Milton in their historical and intellectual context. (Fall Spring)

413. Studies in Renaissance Literature
Varying topics relating to the literature and culture of the Renaissance and Early Modern periods. (Fall Spring)

414. Eighteenth-Century Literature
The writings of John Dryden, Jonathan Swift, Alexander Pope, Samuel Johnson, and their contemporaries. (Fall Spring Summer)

415. Early British Novel
The novel from its beginnings to the early nineteenth century, emphasizing such novelists as Defoe, Fielding, Richardson, and Austen. (Fall Spring)
417. Studies in Eighteenth-Century Literature
Varying topics relating to the literature and culture of England in the period from roughly 1660 to 1800. (Fall Spring)

418. Early American Literature
From 1630 to 1830, including Puritan nonfiction and poetry; exploration narrative; and fiction, drama, and poetry of the Revolutionary and early national eras. (Fall Spring)

420. Romantic Literature: the Gothic Spirit
British romanticism (1780-1830) came to life in the midst of extreme stress and change: revolutionary politics, science, religion, technology, and commerce. Artistically, writers of astounding talents experimented with radical forms of creativity—often at the dangerous edge where dreams and fantasy meet reality. One important form of this fusion is the “gothic”—which uses the medieval, the terrifying, the violent, and the creepy to explore the extremes of intense human experience. We shall focus on the most fascinating and gripping works to emerge from these efforts, such as Mary Shelley’s Frankenstein. (Fall Spring)

421. Victorian Literature
The major intellectual, cultural, and artistic developments of the Victorian period, in prose, drama, verse, and related arts. (Fall Spring)

422. Nineteenth-Century British Novel
Emphasizing such novelists as Dickens, Thackeray, Eliot, and Hardy. (Fall Spring)

423. Studies in Nineteenth-Century Literature
Varying topics relating to the literature and culture of England in the nineteenth century. (Fall Spring)

425. American Renaissance
From 1830 to 1865, including Emerson and the transcendental movement, abolitionist writing and slave narrative, representative fiction, and poetry by Poe, Whitman, Melville, Stowe, and others. (Fall Spring)

426. American Realists
From 1886 to 1912, including poetry by Dickinson and Frost; realist and naturalist fiction by Twain, Wharton, James, Dreiser; representative nonfiction and philosophy. (Fall Spring)

427. American Moderns
From 1913 to 1943, including Eliot, Stevens, Cather, Faulkner, Hemingway, Fitzgerald, O’Neill, W. C. Williams, and others. (Fall Spring)

428. African-American Drama
Study of dramatic works by African-American playwrights during the twentieth and twenty-first century. (Fall Spring)

429. American Fiction Since 1980

430. Studies in American Literature
Varying topics relating to the literature and culture of the Americas. (Fall Spring)

431. Twentieth-Century British Novel
The novel from 1900 to the present, emphasizing such novelists as Conrad, Joyce, Woolf, and Lawrence. (Fall Spring)

432. Modern Literature
A study of English, Irish, and American literature of the early and mid twentieth century, with a focus on the exploratory work of writers such as W. B. Yeats, James Joyce, Ezra Pound, T. S. Eliot, and Virginia Woolf. (Fall Spring)

433. Modern Poetry
An introduction to representative twentieth-century poetry. (Fall Spring)

434. Modern Fiction
Great modern drama from Ibsen to Ionesco as a reflector of the main currents in modern thought and feeling. (Fall Spring)

435. Modern Drama
Great modern dramas from Ibsen to Ionesco as reflectors of the main currents in modern thought and feeling. (Fall Spring)

436. Contemporary Fiction
Examines novels and short fiction by contemporary English and American writers. (Fall Spring Summer)

437. Contemporary Poetry
Poetry in English from around 1945 to the present, emphasizing latter-day transformations of the visions and style of High Modernism. (Fall Spring)

438. Studies in Modern & Contemporary Literature
Varying topics relating to the literature – prose, poetry, and drama – of the later twentieth and twenty-first centuries. (Fall Spring Summer)

440. Literary Criticism and Theory
Study of the methods and conceptual backgrounds of the theoretical study of literature and literary analysis. (Fall Spring)
441. Lyric Poetry
A study of the ways of reading shorter poems in English. (Fall Spring)

442. Topics in Literature
Readings vary according to subject. (Fall Spring)

443. Studies in A Major Author
Intensive study of the writings of a single author or small group of authors from British or American literary traditions. (Fall Spring)

444. Studies in A Literary Tradition
A study of a body of works of literature seen through their particular links to a tradition or historical genre. (Fall Spring)

445. Studies in Literary Mode
Readings vary according to subject. (Fall Spring)

446. Detective Fiction
Discussion of major authors, books of detective fiction, concentrating on the 20thC -- history and development in both England and America. Other authors incl Arthur Conan Doyle, Agatha Christie, John Dickson Carr, Dashiell Hammett, Raymond Chandler, Ross Macdonald. (Fall Spring)

447. Science Fiction
Examines a range of science fiction texts and issues, including works by Mary Shelley, H. G. Wells, Isaac Asimov, Robert Heinlein, Samuel R. Delany, and more. (Fall Spring)

448. Study in Women’s Literature
Writings by women – both literary and non-literary – from a variety of periods and cultures. (Fall Spring)

449. Gender, Writing, and Representation

450. Literature and Ethnicity

451. Studies in Popular Literature

452. Theater in England
Prerequisite: Instructor’s permission is required.
This four-credit intersession course is conducted in London, UK, from late December through early January. We will see, discuss, and write on 16 to 18 plays. The itinerary this year will include world premieres of plays by Alan Bennett, John Logan, Lee Hall, and David Hare; Shakespeare’s Twelfth Night, Tennessee Williams’s Cat on a Hot Tin Roof, John Guare’s Six Degrees of Separation, Tom Stoppard and Andre Previn’s Every Good Boy Deserves a Favour, several musicals, and splendid extravaganzas from the National Theatre such as War Horse and Nation, to name a few. The fee for the course is $2550. (Fall Spring)

453. The Literature of the Bible
Narrative and poetic art of selected biblical texts. (Fall Spring)

454. Arthurian Literature
The origins and later developments of the chivalric romance tradition centering on the legends of King Arthur and his knights. (Fall Spring)

455. Introduction to Film History: Silent Cinema
Intro to history, technology, cultural significance of motion pictures of the “pre-sound” era, screenings of 35mm prints accompanied by live music in the Dryden Theatre. Special attention to major pioneers, Dickson, Porter, Lumière, Méliès, and Griffith, including a variety of internationally produced films selected from the world-famous archival film collection of the George Eastman House. Discussions of origins, development of the motion picture industry and its leading genres up to the general introduction of movies with pre-recorded music, sound and dialog, beginning in 1927. Broad issues relating to the transformation of American and world popular entertainment forms and traditions, in relation to the established performing arts of the period. Relevant connections to preserving the world’s film heritage will be highlighted and the film restoration facilities of the Motion Picture Department will be visited. (Fall Spring)

456. Film History: 1929-1959
A transnational survey of film history, examining the technical and formal aspects of the medium in its production and exhibition. As we explore the development of cinema, we will address aesthetic and technological issues. i.e. how did the development of sound technology affect film form? How did it affect Cross-cultural cinematic exchange? What is the significance of genre across various film traditions? What did the studio system contribute to Hollywood’s success in the international market? How did immigrant and exiled film personnel shape the industries they joined? Weekly screenings and film journals required. (Fall Spring)

457. Film History: 1959-1989
This course will explore the developments in world cinema—in industrial, technological, social, and political—in the second half of the sound period (1959 to the present). (Fall Spring)

458. Film Analysis
not taught anymore.

459. Popular Film Genres
An intensive study of selected types of popular films in their larger cultural context. Same as FMS 251. (Fall Spring)
460. Studies in Film History
This course may approach a national cinema, a director, a movement, or a genre with an emphasis on period or historical context. (Fall Spring)

461. Film Theory
An introduction to the history, the theory, and especially the practice of criticism. Same as FMS 255. (Fall Spring)

462. Studies in A International Cinema
Films from a particular international cinema—British, Japanese, German, French, Italian, and others from various periods. Same as FMS 256. (Fall Spring)

463. Media Studies
Addresses the history and theory of a range of communications media and visual technologies in science, industry, and popular culture. (Fall Spring)

464. Films of the 1930s
A course in the works and career of an outstanding and identifiable film director: Hitchcock, Warhol, Huston, Buñuel, Renoir, etc. (Fall Spring Summer)

465. Issues in Film
The course takes up particular concepts, ideas, and ideology in film, often spanning periods, nations, and genres. Same as FMS 252. (Fall Spring)

466. Issues in Film Theory

467. Topics in Media Studies
Same as FMS 259. (Fall Spring)

468. The Matter With Men Film/Soc
Same as FMS 254. (Fall Spring)

469. Museum Practice
Restricted to Selznick Students (Fall Spring)

470. Curatorial Theory & Practice
Restricted to Selznick Students (Fall Spring)

471. Film Conservation & Restoration
Restricted to Selznick Students (Fall Spring)

472. Moving Image Archive Management
Restricted to Selznick Students (Fall Spring)

473. Laboratory Work
Restricted to Selznick Students (Fall Spring)

474. Personal Project
Restricted to Selznick Students (Fall Spring)

475. Adv Creative Writing: fiction
Seminar in fiction writing. Emphasis on individual development of style. (Fall Spring)

476. Adv Creative Writing: Poetry
After reading a wide variety of poems in different forms, students will write metered poems, rhymed poems, free-verse poems, and several more elaborately patterned poems (sestinas, villanelles, pantoums). They will also be asked to revise these poems substantially. The goal of the course is simply to become a better writer by recognizing that the beauty and power of all linguistic utterance is driven by its form. (Fall Spring)

477. Screenwriting
The primary text for this course is students’ own scripts in progress. The course also examines various professional scripts, both film and television. (Fall Spring)

478. Advanced Playwriting

480. Advanced Seminar
Advanced seminars focus on a particular body of works (literary or cinematic), a special research topic, or a particular critical or theoretical issue. One or more extended critical essays will be required. Open to junior and senior English majors. Others may be admitted by permission of instructor. (Fall Spring)

481. Advanced Feature Writing
Skills essential to good feature writing, from interviewing to structuring to revising. (Fall Spring)

482. Humor Writing

483. Media Abc
Provides a historical and critical introduction to the idea of medium and media, including books, paint, electronic files, music, photography, etc. (Fall Spring)

484. Orality, Language & Literacy
An inquiry into how literacy capability at different historical moments has affected the uses of texts, performances, and speech genres. Attention is given to literary, sacred, and secular texts. (Fall Spring)
485. Humanities Research Lab

487. Studies in Translation
A study of the theoretical backgrounds, practical challenges, and creative activity of literary translation. (Fall Spring)

488. Lang in Science & Religion

489. Selznick Colloquium
not offered anymore

491. Master’s Reading Course
Credit to be arranged. (Fall Spring)

492. Special Topics

494. M.A. Research Internship

495. Master’s Research

500. Graduate Colloquium
Introduction to Graduate Studies in English is a semester-long introduction to doctoral study in English. (Fall Spring)

501. Theory & Prac of Textual Crit

504. Chaucer: Major Works
The principal works of Chaucer, in their historical and intellectual context. Readings in Middle English. (Fall Spring)

506. Old English Literature
To learn the Old English language, with translations provided for most of the texts as a guide only. We will explore the dark world of Anglo-Saxon writing for its illuminations -- with emphasis on loss, love, hardship, riddle, wisdom, and the spiritual and magical powers of writing in a culture that stood on the cusp of orality and literacy. (Fall Spring Summer)

507. Middle English Literature
Poetry, prose, and drama of the thirteenth, fourteenth, and fifteenth centuries, exclusive of Chaucer. Readings in Middle English. (Fall Spring)

508. Medieval Literary Modes
Readings vary according to subject. (Fall Spring)

509. Renaissance & 17th C Lyric
Expore the full range of Shakespeare’s theater, including history plays, comedy, tragedy, and romance. (Fall Spring Summer)

510. Shakespeare
Expore the full range of Shakespeare’s theater, including history plays, comedy, tragedy, and romance. (Fall Spring Summer)

512. Studies in Sixteenth & Seventeenth-Century Literature
Topic to be announced. (Fall Spring)

514. Studies in Renaissance Culture
Topic to be announced. (Fall Spring)

516. Elizabethan and Jacobean Drama
This course may focus on drama written by Shakespeare’s contemporaries. Become familiar with descriptions of 16th- & early 17th-C theatrical spaces. Sort through the plays’ depiction of the proper relations between ruler and subject, husband and wife, parents and children, and European and non-European characters. Applicable English Cluster: Plays, Playwrights, and Theater. (Fall Spring)

524. Restoration & Eighteenth-Century Literature

525. The Early English Novel

526. Studies in Eighteenth-Century Culture

529. English Romanticism
Major writers, other than novelists, of the early nineteenth century, with particular emphasis on poets from Blake through Keats. (Fall Spring)

530. Studies in Victorian Literature & Culture
Varying topics relating to the literature and culture. (Fall Spring Summer)

531. Victorian Renaissance

533. Victorian Poetry

538. Studies in Early American Literature
We will consider a broad range of American writing from this period, from the jeremiads of English Puritan reformers to the literature of the American revolution. (Fall Spring Summer)

539. Studies in Nineteenth-Century American Lit I

540. Studies in Nineteenth-Century American Literature II

541. Rhetoric of the Frame

543. Studies in American Culture

545. Studies in African-American Lit & Culture
Studies in the English Novel

Wwi & the Culture of Memory

The novel from 1900 to the present, emphasizing such novelists as Conrad, Joyce, Woolf, and Lawrence. (Fall Spring Summer)

Modern Poetry

Examine the rise of the poetic series (as opposed to the poetic sequence) in modernist writing. (Fall Spring)

Criticism

This seminar studies the developments in literary theory over the past eighty years. Early in the twentieth century criticism and theory followed the success of science, trying to bring order and method to the subject. (Fall Spring)

Problems in Contemporary Theory

Issues in Feminism

Cultural Studies

In recent decades, many scholars of literature and other humanists have refocused their attention on a set of connections once consigned to the past: the historical and theoretical links between religion, science, and literary representation. This course introduces several important contexts and critical conversations stemming from these intersections. Areas of focus will include the history of ideas, political theology, post-colonial theory, and science and literature. We will read a number of primary sources, including key texts by Hobbes, Leibniz, Locke, and Spinoza, as well as important recent work by Talal Asad, Saba Mahmood, Charles Taylor, and others. (Fall Spring)

Special Literary Problems

“The lyric” has always been an elusive quarry, as is the question of what kinds of critical tools we need to listen to, analyze, and animate lyric poems. The seminar will combine the intense study of the work of particular lyric poets with the close reading of texts by important critics and theorists of the lyric. Among the other questions we’ll consider are the nature (and fiction) of voice in lyric, the fate of the lyric “I,” the importance of formal elements (meter and rhyme, the organization of sound and syntax), the nature of linguistic play and “difficulty” in lyric poetry, the work of metaphor, the shape of poetic memory. The poems taken up will include Shakespeare’s sonnets, the lyrics of John Donne, and poems by John Keats, Emily Dickinson, Thomas Hardy, and Wallace Stevens. We’ll also be devoting time to crucial critical texts by William Empson, John Hollander, R. P. Blackmur, Christopher Ricks, Sharon Cameron, Anne Carson, and Jonathan Culler among others. (Fall Spring)

Video History and Theory

Studies in Rhetoric & Literacy

Lang & Lit Universty 1155-Pres

Studies 20thc Lit:int’l Fict

Writing Pedagogy

Issues on rhetoric, composition, literacy, and cultural studies that focus on the teaching of writing. We examine a significant range of theory and research on teaching and academic writing. (Fall Spring)

Practicum in Teaching of Writing

Credit—two hours (Fall Spring)

Teaching Apprenticeship

Pedagogical Training

Visual & Cultural Studies

Humanities Research Lab

PhD Readings

Credit to be arranged. (Fall Spring)

Historical & Conceptual Fields

PhD Research

Credit to be arranged The following courses may be taken for four hours of graduate credit. (Fall Spring)

PhD Research in Absentia

Summer in Residence - MA

Cont of Master’s Enrollment

Masters Dissertation

Master’s Dissertation

Masters Dissertaton Absentia
985. Leave of Absence
986V. Full Time Visiting Student
990. Summer in Residence
995. Cont of Doctoral Enrollment
997. Doctoral Dissertation
997A. Doct Dissertatn in Absentia
999. Doctoral Dissertation
999A. Doct Dissertatn in Absentia
999B. PhD in-Absentia Abroad

Film and Media Studies

407. Miyazaki & Ghibli
413. Race & Gender in Popular Film
This course explores Hollywood's fascination with race and gender as social issues and as spectacles. In particular, we will focus on the ways that social difference have become the sites of conflicted narrative and visual interactions in our films. To examine competing representations of racial difference and sexual difference in US culture, we analyze popular films from the 1950's to the present. (Fall)

415. Issues Film:family Repression

420. Film as Object
Film Studies involves the critical analysis of the pictorial and narrative qualities of motion pictures, film theory, and film history, understanding film as both industry and creative art. This course unconventionally focuses on the tangible object at the origin of the onscreen image, and what we can learn about the social, cultural and historical value of motion pictures and national film cinemas through an understanding of Film as an organic element with a finite life cycle. Focus is on the photographic element, but includes a consideration of alternative capture media. Enrollment limited to 15. (Spring)

422. Art & the City: Ny in the 70s
The recession & fiscal crisis of the 1970s was paradoxically a highly productive period of artistic experimentation in New York City. In the wake of the transforming art movements of the 1960s--Pop, Minimalism, and Conceptual Art--the 1970s saw the invention of new and hybrid media: video art, performance art, & site-specific installation works. By the end of the decade a new group of artists that came to be known as the Pictures Generation began showing in alternative spaces such as Artists Space. In this seminar we will study how the de-industrialization of New York contributed to new kinds of art making & examine how art works take the city as their subject. Among the artists we will consider are Bernd & Hilla Becher, Gordon Matta-Clark, Joan Jonas, Peter Hujar, Danny Lyon, Cindy Sherman, and Thomas Struth. Avant-garde film also took the city as its subject; the course will include the work such film & video-makers as Dara Birnbaum, Ernie Gehr, Peter Hutton, Babette Mangolte, and Charles Simonds. (Fall)

426. Issues Film:documtry, Mock
427. Poetics of Television
432. The Horror Film
433. Social Uses of Media
438. Popular Film: Gangster Film

439. Popular Film Genres: Vampire

443. Film as Object

446. Bright Lights, Big City

In the early twentieth century, our conceptualization of the city had a significant impact on how we understood our interactions with others and the notion of the individual. In this will look at a wide variety of texts including newspaper articles, essays, films and fiction to explore the following questions. What is the relationship between technology and man? How does the individual navigate the space of the city? What role do class and gender play in our ability to move through the city? What is the relationship between modernity and urban life? (Spring)

448. Film History: 1929-1959

460. Screenwriting

463. Clocks and Computers

473. Akira Kurosawa

An intensive study of the films of Akira Kurosawa, Japan’s most durable and visible auteur. Thanks to Kurosawa’s prolific output during his fifty-year career, from his debut in the 1940s to his recent work in the 1990s, an analysis of his films also offers the opportunity to examine some of the major cultural, political, and social issues and events that have left an imprint on the theory and production of film in Japan. We will also consider the work of many individuals (for example, the screenwriter Shinobu Hashimoto) who made important contributions to creating the Kurosawa opus, and whose careers are closely associated with Kurosawa. (Fall)

480. French Cinema: the New Wave

488. Mothers, Comrades & Whores

490. Hollywood Behind the Wall

491. Master’s Reading Course

493. Russia Goes to Movies

495. New German Cinema

498. Contemporary Japanese Cinema

Japanese cinema has changed radically since the 1980s: independent productions are now a commercial standard; a new home entertainment market irrecoverably transformed patterns of consumption; an increasingly global market for Japanese (and, more broadly, Asian) film has generated “brand name” recognition at a new level of popularity worldwide. Concurrent demographic, socio-political, and economic changes have ruptured conventional conceptions of national identity; Japan has in particular been forced to reconsider its 20th century identity crisis as part of Asia. This course explores how recent films reflect such developments (e.g., reworking and reinterpreting once familiar genres) and the significance of contemporary works within the broader context of a global market (e.g., the singular popularity of specific genres like Horror, as well as the broad diversity such phenomena can conceal). (Spring)

499. Atomic Creatures: Godzilla

A study of the phenomenon that generated and helped define the Japanese kaiju eiga (monster film) genre: the Godzilla series that began with the original film by Inoshiro Honda (Gojira, 1954), and its better-known US remake (Godzilla, King of the Monsters, 1956). The larger context of the course is a critical investigation of the science-fiction/horror/creature feature film generated in the late 1940’s by the dawn of the nuclear age. The course will begin with a sampling of seminal non-Japanese titles that created a paradigm for the Godzilla film, and will address the historical and social contexts for the series erratic trajectory since 1954. Students are responsible for assigned readings and are required to attend screenings. (Fall)

502. Andy Warhol: Topics in Cont

508. Dance, Art, and Film

This course explores relations among dance, art, and film at significant moments in the 20th and 21st centuries. We will study instances in which the forms are particularly closely aligned, including the famous productions by artists such as Gontcharova, Picasso, and Matisse, for Diaghilev’s Ballets Russes; Martha Graham’s partnership with Isamu Noguchi; and Merce Cunningham’s work with Robert Rauschenberg. We will also look simply at how dance is filmed or how dance uses film. The course will concentrate on two figures of the postwar American avant-garde: Merce Cunningham and Yvonne Rainer. Cunningham’s dances choreographed for film in collaboration with film- and video-makers and Rainer’s move from choreography to filmmaking and eventually to hybrids of the two will constitute the core of the course. (Fall)

555. Feminist Film Theory

Feminism has had a powerful impact on the developing field of film theory from the 1970s to the present. This course will examine the major feminist work on film, moving from the earlier text-based psychoanalytic theories of representation to theories of feminine spectatorship to studies of reception contexts and audience. We will also give some attention to the very important role of feminist theory in television studies. Weekly screenings, keyed to the readings, will allow us to test the value of these positions for close critical analysis of the film or television text. Readings to include: Laura Mulvey, Kaja Silverman, Constance Penley, Judith Mayne, Linda Williams, Jacqueline Bobo, Valerie Smith, Lynn Spigel, Lynne Joyrich, Julie D’Acci. (Spring)
556. Classical Film Theory

This course examines the philosophical, aesthetic, and social issues that are central to classical film theory. It traces the historical development of film theory from 1900 to the 1950s. We will begin with thinkers in the period of early cinema, including Germaine Dulac, Jean and Marie Epstein, and then we will examine the development of film theory in the work of later theorists, such as Jean Mitry, Sergei Eisenstein, Dziga Vertov, Siegfried Kracauer, Walter Benjamin, Andre Bazin, and Christian Metz. Weekly screenings of historically contemporary films will allow us to examine the ongoing dialogue between the evolving medium and the developing theoretical discussion. (Spring)

History

Professors Borus, Brown, Inikori, Kaeuper, Mandala, Outram, Rubin, Slaughter, Smoller, Weaver, Westbrook
Associate Professors Devaney, Hudson, Jarvis, Lenoe
Assistant Professors Fleischman, Ho, Sierra, Theobald, Zhang
Joint Appointments: Associate Professors Beaumont, Gamm, Pedersen
Lecturer Ball
Adjunct Instructor Pierce

The Department of History offers programs of study leading to the degrees of Doctor of Philosophy and Master of Arts. The program leading to the doctorate trains students to be accomplished professional historians in a variety of fields and specialties with a particular emphasis on transnational and comparative history. A detailed description of the graduate program for the doctorate may be obtained on the department’s website www.rochester.edu/college/his.

Programs of study are tailored to individual student need and interest in consultation with the advisor and the director of graduate studies. Doctoral students complete two years of coursework (one and a half years if they enter with an MA). During that span they are required to declare two research and two teaching fields.

Research fields are specialized and concentrated interests that should support dissertation work. Examination for competence consists of essays written during the first and second year. Examples include Intellectual History, African-American migration, Public Health, and similar specialties and concentrations that the faculty offer.

Teaching fields are defined as areas that PhD candidates are prepared to teach as survey courses. Examples include the American and the World sequence, Western Civilization, and Global History. Competence in teaching fields is tested by a written and an oral examination. Teaching fields are examined at the beginning of the third year of study.

Students are also required to write one paper based on original research during each of the first two years in residence and to take the two-course introductory sequence (HIS 500 and HIS 501). They are also expected to submit and defend a prospectus for the doctoral dissertation and defend the dissertation upon completion. The prospectus defense should take place within three months of passing the written and oral qualifying examinations.

Ordinarily, PhD candidates must serve as teaching assistants in the third year of the program and co-teach with a faculty member in the fourth or fifth year, depending on the demands of their dissertation research. The duties associated with teaching are considered an integral part of the program and faculty evaluate students during the course of their teaching. Language competence is required as needed.

For information on the MA degree, please see the department’s website: www.rochester.edu/college/his.
400. The History of Nature
This course explores the history of the idea and condition of nature from ancient times to the present. Drawing on contemporary historical scholarship as well as a range of thinkers and writers from Petrarch to Thoreau and beyond, we will study the many ways in which humans have thought about and treated the natural world around them and how the natural world has shaped human history in turn. Some background in history is recommended.

401. Modernity and Modernism: Topics Course
A study of selected topics in the history of modern thought and culture in Europe and the United States.

403. International Human Rights
What does it mean to be human? What political, economic, religious, social, or sexual rights might be part of different people’s working definitions? This course will look at both a) the historical development of conflicting theories of human rights and b) more contemporary debates about their ideal extent, their exercise, and their enforcement. Special topics will include debates over the meaning of the American and French Revolutions, the fight to design an International Declaration of Human Rights in the aftermath of World War II, the history of organizations such as Amnesty International, and the controversy around UN events such as the 1995 World Conference on Women in Beijing, the 2002 World Summit on Sustainable Development in Rio de Janeiro, and the 2000 and 2005 Millennium Summits in New York City.

404. Readings in Atlantic History

405. Maritime Atlantic World
Study of European expansion into Africa and the Americas from the ages of Discovery to Revolution has taken many forms. Some pursued their investigations topically (slavery, migration, economic development, etc.) and others focused on particular colonies or regions. We shift the focus of inquiry to the Atlantic Ocean itself, as the geographic center of an expanding European world. Rather than treat the ocean as peripheral while studying the settlement of the Atlantic coast, we will be primarily concerned with activities that took place upon its watery face, delving into the lives of the tens of thousands of mariners who were catalysts in identity formation, migration, and economic development. Our focus will be on three topics: migration, (forced and free), maritime activities (seafaring, shipping, and fishing.), and trade (how merchants did business and integrated regional economies). By the end, you will hopefully appreciate the centrality of the sea to the development of Africa, Europe, and the Americas.

406. Evolution of the Current World Economic Order From 1500
The course traces the historical origins of the integration and hierarchical structure of the current global economy. It examines specifically the historical forces which produced the unequal international division of labor between industrial and non-industrial nations, starting with the British Industrial Revolution which occurred within the Atlantic world economy. The rise and fall of the USSR and the command economies of Eastern Europe are examined in the context of efforts by underdeveloped countries to improve their performance and location within the global economy. The more recent successes of some Asian countries and the continuing external debt problems of Latin American and African countries are also examined with the conceptual framework of international political economy to predict the probable future of all poor peoples both in the poor and in the rich countries.

408. The Global City
As of 2007, the majority of the world population has lived in cities. This course explores the development of global urbanism since 1945. Placing the global city in the historical context of urban settlement, we will focus on new forms of urban political and social organization, both formal and informal, as they have developed in the contemporary city. We will engage a range of complex policy issues confronting the global city, including issues of environmental and social justice, global markets and migrant labor, the infrastructural challenges of large-scale urban settlement, squatter communities and informal urbanism, and urban planning and governance.

411. The Atlantic Slave Trade and Africa, 1650-1851
By the middle of the 19th c. a highly integrated economic system, called the Atlantic Economic Order, had emerged, linking together through a web of multilateral trade the economies of the Atlantic basin that remained unconnected in the late 15th c. The economies of Africa occupied the lowest position within this Economic Order. We examine the extent to which the Transatlantic Slave Trade could help explain this weak position. Beginning with a general view of the level of socioeconomic development in Africa by the late 15th c., relative to other regions in the Atlantic basin, we will proceed to examine the impact of the Atlantic slave trade on the competitive development of commodity production in Africa for the evolving Atlantic market of the period, as well as the socioeconomic and political consequences of the export slave trade within Africa. One major theme of the course is the extent to which the Trans-Atlantic Slave Trade limited the development of capitalism in Africa during the period in question.

412. Global Crime and Detection
This course will examine on how detective and police fiction reveals the political and cultural tensions and conflicts of a society. Our focus will be global and comparative, concentrating on post-World War II (1945 - ) life. Among the issues at the heart of the exploration are explore the limitations of social democracy and neutrality in Scandinavia, which has of late excelled in the genre, the domination of landholding families in Sicily, the corporate domination of Barcelona, the oppressiveness of apartheid in
Natal, South Africa, the undemocratic rule of the ruling PRI in Mexico, the ideological blindness and bureaucratic inefficiency of Communism in China and the strange combination of capitalism and feudal structure in Japan. Supplementing each story of crime and detection will be short historical readings.

420. Topics in Medieval European History
Selected problems in the political, social, and intellectual history of the Middle Ages.

421. Topics in Early Modern European History
Although most people in early modern Europe lived in rural settings, cities assumed new importance during this period. We will examine these cities as capitol for newly centralized empires and as engines of commerce while also considering how urban communities responded to challenges such as poverty, crime, demographic change, and social unrest. Through case studies including Venice, Amsterdam, London, Seville, and Constantinople, we will also explore how cities brought together elite values and the ‘culture of the street’ and thus played a key role in transitions from medieval to modern society.

422. Topics in European Cultural History
Novels, plays, music, dance, poetry, painting ... How can we use individual artistic creations as a way of learning about the politics, economics, social structures, and psychological attitudes of the past? This course will answer that question by focusing on a series of modern European examples from the French Revolution through the Second World War.

423. World War II: Eastern Front
This course is centered on class discussion of the readings. There will be little lecture time. We will focus on the history of the Soviet Union’s struggle with Nazi Germany from 1941-1945, the largest and bloodiest military conflict in human history. Readings will deal with the Holocaust, the history of military operations, the Red Army’s “learning curve” in its battle with the Wehrmacht, and everyday life on Nazi-occupied territory as well as the Soviet “home front.” Viewing and discussion of documentary and fictional films will be a significant part of the class.

424. 424. Microhistory

425. 425. Real Existing Socialism
This course examines the diverse history of socialist ideology as lived-experience across Europe. It begins with the first theorists of socialism and places their ideas in the context of a rapidly industrializing Europe in Germany, France, and Great Britain. From the Paris Commune to the Iron Curtain, the course explores the surprising varieties of socialist societies that emerged in the 19th and 20th centuries. This course asks students to consider: how were these societies ruled and why did they fail? To what extent were they influenced by the political philosophies of the 19th century? To what extent were they a product of geopolitical conflicts and the failures of capitalism in the 20th? How did socialist leaders and citizens imagine the future of socialist development? What was the every-day lived experience of secret police and state force, but also of food, fashion, music, literature, and film?

429. History of Friendship

430. War, Money, and Ordinary People
This course covers topics such as the changing nature of warfare, the lives of ordinary people, how the state attempted to control their private lives. It also looks at the global world which had emerged along with the growth of national feeling.

431. Europe in 1215
Three events taking place in 1215 provide windows for close looks into the Medieval world of Western Europe. (1) The movement for a measure of control over the rapidly expanding royal power in England produced the Magna Carta. (2) The Fourth Lateran Council legislated important elements for the centralizing and papal-directed church and stimulated the creation of a theology to reach the laity more fully. (3) Poets began writing the vast prose cycle of Arthurian, chivalric romances that we know as the Vulgate or Lancelot-Grail cycle. In short, the course considers politics, law and constitutionalism in the growth of medieval monarchy, the centralizing clerical church and its relationship with the laity, and the world of Arthurian romance. We will take up each subject in turn before each student selects a theme within one of the topics for a research paper.

432. Stalinism
In the early 1930s Joseph Stalin consolidated his one-man dictatorship in the USSR. He and his lieutenants revolutionized Soviet society and created a new and unique political and economic system, in large part through the use of state terror. In 1941-1945 Stalin led the Soviet Union in its death struggle with Nazi Germany; in the late 1940s and early 1950s he was one of the architects of the Cold War. In this class we will study social, political, economic and cultural aspects of Stalinism. The course will be focused on discussion of readings and writing of an original research paper, about 20 pages long.

433. Russia in East Asia
We begin with the study of various approaches to analyzing the relations between society’s balance of power realism, world systems theory, and anthropological/cultural analyses. We then use these analytical tools to examine relations between Russia and neighboring societies in East Asia over the last 150 years, beginning with the Chinese cession of the Amur region to Russia in 1868 and concluding with discussion of current competition for access to fossil fuel resources in the region. We will discuss episodes such as the Russian-Chinese-Japanese competition for influence in Korea in the 1880s, the construction of the
Trans-Siberian Railway, the Russo-Japanese War, Soviet border policy and the undeclared war with Japan in the 1930s, the Soviet deportation of 700,000 Koreans from border regions in 1937-1938, the Korean War of 1950-1953, and Sino-Soviet relations after the victory of the Chinese Communist revolution in 1949. Class will be mostly devoted to discussion of readings and preparation of a final paper. (Fall)

434. The Soviet Union and the Cold War
This seminar, based around discussion of readings and a major research paper, will be focused on the Soviet side of the Cold War, including the conflict's impact on Soviet culture, society, daily life, and the economy. (Spring)

435. The Age of Great Cities: Europe in the Nineteenth Century

440. Modernity Through East Asian Eyes
What is modernity? What does it mean in China, Japan, and Korea? These are vital questions—but let’s not be scared away just because they seem abstract. We will seek answers together through history, literature, and film. Each week we will discuss a theme (such as WAR, POWER, TIME, and RESISTANCE) through films and readings that help us see the puzzle one piece at a time. Our goal is to uncover how modernity has been experienced and pictured on the other side of the globe. In the process, we may gain not only a better understanding of East Asia, but also of ourselves. Note: this seminar assumes at least some basic knowledge of Asian history or society. Contact the instructor if you have not taken at least one course on Asia.

441. Culture and Religion of the Indian Ocean
Long before the beginning of European expansion in the sixteenth century, the Indian Ocean constituted a cosmopolitan arena within which traders, religious scholars and mystics affiliated with different world religions circulated with minimal friction. Even during the period of high colonialism, when most shipping was controlled by Christian Europeans, Hindu, Buddhist and Islamic scholars continued to circulate throughout the region. This course will explore the transformations all four religious traditions underwent as they interacted during the last two centuries in this region. Readings include: Peter van der Veer, Imperial Encounters; Sugata Bose, A Hundred Horizons; Engseng Ho, The Graves of Tarim; Peter Metcalf, Imperial Connections.

442. Rich China, Poor China
The modern Chinese state has been shaped by its efforts to tackle economic strains. Imperial China collapsed in the throes of foreign imperialism and trade deficits. Republican China, being one of the few silver-standard countries in a gold-standard world, ran out of luck in fighting inflation. Socialist China became obsessed with a self-reliant economy, and established a state industry at the costs of impoverishing the entire rural population. And today, while China holds gigantic foreign reserves and launches spectacular Olympics and space ships, social welfare and individual rights have receded into a dim future. After toiling for gross economic surplus, will the Chinese people finally be the masters that share the fortune of the state? Come join me in this century-long and still ongoing journey, and learn the story of modern China’s search for wealth and power.

446. Digital History: Topics Course
Interested in learning about global trade and making maps at the same time? In this class we will look at fifteen major commodities that shaped the economic landscape of the modern world: chocolate, coffee, cotton, fur, opium, oil, porcelain, silver and gold, spices, sugar, tea, timber, tobacco, wheat, and wine. Then we will take one step further, using ArcGIS to translate our book knowledge into creative digital maps. There are no prerequisites required; just bring your curiosity.

450. Of Captors and Captives

451. Urban History in Latin America, 1850-Present

458. Women’s Lives and Letters: America 1830-1880

Childbirth is often viewed as a “natural” female biological function. As a result, many people assume that birthing is essentially the same across historical eras and cultures. In this class, we will take the opposite approach to the topics of childbirth and reproductive health. Our objective will be to explore how women’s reproductive experiences and the meanings attached to such experiences have changed over time and why. We will consider topics such as the evolution of the field of obstetrics, the decline and resurgence of midwifery, politics and policies surrounding infant and maternal mortality, and the development and availability of various reproductive technologies. This is a research seminar, so students will further explore these issues through their own research and writing on some aspect of the history of reproduction. Readings and discussions will focus on the United States in the nineteenth and twentieth centuries, but students may explore the location and period of their choice in their papers.

460. America and the World to 1865

461. American and the World Since 1865

462. American Thought: Topics Course
Selected topics in American thought, treating it in its social, political, and cultural context.

463. American Culture in the Great Depression and World War II
This course is an investigation of American cultural life during the Great Depression and Second World War (1929-1945). Emphasis on the interpretation of primary resources. Class will
examine a range of material: autobiography, reportage, novels, movies, art, architecture, material culture, photography, social thought, and music. No prerequisites, though HIS 148 and/or HIS 242 would be helpful. Reading and discussion; two short papers and one longer paper.

464. The Black Family in Slavery and Freedom
After a discussion of the Moynihan Report controversy and an assessment of the literature on the black family, the readings will investigate why and how stable black families were encouraged, and how they developed under slavery. The impact of factors such as economics, politics, religion, gender, medicine, and the proximity of free families, on the structure of the black family will be given special attention. In this way, the structure of the slave family on the eve of Emancipation, and its preparedness for freedom, will be tested and assessed. Students will be encouraged to identify persistent links between the “history” of slavery and the black family, and the development of social policy.

465. Topics in Early American History
This seminar introduces students to recent scholarship in the study of early America. Topics and approaches may include slavery and the formation of African-American culture, Revolutionary resistance, Euro-Indian encounters, religion and witchcraft, micro-history, gender roles, warfare, and environmental history. Using selected monographs, we will not only examine various interpretations of past events, but also dissect texts to discern how historians use evidence from the past to construct historical narratives - how historians “make” history.

466. Topics in Revolutionary America
This course explores the roots of the American Revolution and uses recent scholarship to consider how the war affected a wide array of Americans. We will also situate the American Revolution in its Atlantic and global contexts as we examine the course of the war and its enduring legacies.

467. American Culture At Mid-Twentieth Century, 1946-1975
The seminar addresses the central themes of American cultural life in the mid-twentieth century -- the growing importance of psychological explanation, the emphasis on remaking norms, and the difficulties in maintaining or find oneself. Among the issues considered are the contributions of Jews and African-Americans, abstract expressionism, the rise of youth as cultural producers, the new sexuality, and feminism.

469. Benjamin Franklin’s America

472. Topics in 20th Century US History

474. Topics in American Social Thought
This course delves into the conceptions and understanding that Americans have devised to understand their collective life. Emphasis on formal thought that maps the structure of society and dynamics of social activity. Topics will vary from year to year but among possible investigations are American understanding of capitalism, the nature of social justice, and the problem of social cohesion.

475. When New York Was the Wild West
This course explores New York’s history from Seneca settlement to Seneca Falls, using recent scholarship to consider Iroquois, Dutch, English, and American periods of history. Specific topics include New York City and its hinterland, the shift from Dutch to English rule, Slavery in New York City, British-occupied New York and the American Revolution in New York State, 18th and 19th century religious movements, the dynamics of frontier settlement, and the Erie Canal. Students will devise and write an original primary research paper on a particular aspect or period of New York history.

477. Emergence of the Modern Congress
Through intensive reading and discussion, we will analyze the major institutional features of Congress, with an emphasis on historical development. We will examine the basic institutions of the House and Senate—committees, parties, leaders, and rules. In doing this, we will consider the rise of careerism, the seniority system, agenda-setting, electoral concerns, divided government, efforts at institutional reform, party polarization, gridlock, and the Senate filibuster.

478. The Seward Family’s Civil War
A hands-on introduction to web-design and historical editing using the Papers of William Henry Seward (1801-1872), Governor of New York, US Senator, and Secretary of State under Abraham Lincoln during the Civil War. The Rush Rhees Rare Books, Special Collections, and Preservation Department holds the collection, which contains Seward’s public and private correspondence, and that of family members, including his wife, five children, and their extended family. The course will include background reading on the Civil War era, technical instruction on web design in a computer lab, transcribing, editing, annotating historical manuscripts using the original documents, and participation in construction of a website for a digital edition of the papers. This course is a prerequisite for HIS 320: Seward Family in Peace and War, and internships working on the Seward Family digital editorial project.

479. The Seward Family in Peace and War

480. The Visual Culture of Heritage and Identity
Cultural critic Stuart Hall has observed that Heritage is a discursive practice. It is one of the ways in which the nation slowly constructs for itself a sort of collective social memory. This upper level seminar will look at case studies of how people (through the collectivities of gender, ethnicity, race, or nation) construct visual narratives about the past. Among the topics for
consideration are Holocaust memorials, Native American and Polynesian museums and cultural centers, African American quilt histories, and even individual artists projects of the last few decades (Judy Chicago, Fred Wilson, Silvia Gruner, José Bedia, and Jolene Rickard, among others). We will see how various constituencies have borrowed from what Arjun Appadurai has called a warehouse of cultural scenarios in order to construct a useable past that supplies what is needed in the present, irrespective of its relationship to the verifiable realities of the past.

481. Just and Unjust Wars
The seminar considers the concept of just war and the application of just war theory to specific historical cases. Together we will discuss several models Arendt, Augustine, Clausewitz, and Waltzer at the beginning of the semester, and at least one scholars' application of theory to a specific case. Students will identify the specific war on which they intend to focus their research, primary and secondary sources they will consult, and the questions they will ask. At different stages we will meet to discuss shared readings, one-page research proposals, bibliographies, thesis statements, first paragraphs, and first drafts of research papers.

482. Apocalypse Now...and Then: A History of Apocalyptic Thought
This seminar examines the history of beliefs about the end of the world in the western Judeo-Christian tradition. We will examine such topics as the birth of apocalyptic thought, the medieval development of various aspects of traditions about the End (such as the figure of Antichrist and millenarian traditions), millennial influences on the discovery and colonization of the New World, millennial movements of the last two centuries (such as the Millerites and the Mormons), and contemporary apocalyptic scenarios. A major theme of the course will be the flexibility of apocalyptic language, its ability to interpret various historical situations, and its power to move people to acceptance or action.

483. Disease and Society From Antiquity to the Present
What is the relationship between disease and the society in which it strikes? How do societies define disease, and how does culture affect the treatment of the sick? How have scholars written the history of disease? In this research seminar, students will explore such questions by examining interactions between disease and society in western cultures from antiquity through the present, at the same time pondering what this insight can tell us as we face the frightening prospect of new killers like Ebola and resistant strains of old diseases like tuberculosis. Throughout, the course will insist that the experience of disease is not simply a biological fact, but is conditioned by the culture in which we live.

488. Research Colloquium: Lewis Henry Morgan’s Bicentennial
This colloquium will focus on the life, works and contested legacies of Lewis Henry Morgan (1818-1881), a Rochester attorney and founding figure of American anthropology. Students will conduct original research using archival materials and museum collections on campus and at local cultural institutions. This research will provide content for exhibitions, events, and a website to be planned in connection with the bicentennial of Morgan’s birth.

489. Archaeology Field and Research Methods
Using Smiths Island, Bermuda, as a historical laboratory, this course trains students in archival research and archaeological survey, excavation, and lab analysis techniques and prepares them for professional work as historical archaeologists. Students will also learn about Bermudian and Atlantic historical developments, trade relations, and slavery and the African diaspora since 1610. Participants will also be introduced to archaeological conservation, museum studies, and underwater archaeological techniques. No prior archaeology experience is necessary.

491. Reading Course At the Master’s Level
Individual, specialized reading courses; topics, relevant to student’s program, chosen in consultation with faculty member. (Fall Spring)

495. Research At the Master’s Level
Graduate level research course for the M.A. level. (Fall Spring)

496. Extended Reading At the M.A.
Individual, specialized extended reading courses; topics, relevant to student’s program, chosen in consultation with faculty member. (Fall Spring)

498. Arch Field & Research Methods

499. Archlgy Field & Resrch Methods

500. Problems in Historical Analysis
This course addresses questions of interest to beginning graduate students in history. These may include: the history of the historical profession, styles of historical writing, relations between history and literature, ethno-history, and the functions of history as criticism and as social memory. (Fall Spring)

501. Worlds of Inquiry
Introduces students to the interests of the Rochester faculty, which fall into three spheres of inquiry -- the world of nations, which emphasizes the complications of government, nationalism, war, and power; the world of goods, which concentrates on commerce and trade, the supporting institutions and the consequence of various modes of production and consumption, and students will read a sequence of exemplary works in each world — works that will acquaint them with the rudiments of each sphere, the problems under investigation and some of the solutions offered. (Fall Spring)
510. Advanced Historical Studies
511. Readings in 19th Century American History
512. Research in 19th Century American Intellectual History
513. Readings in 20th Century American Intellectual History
514. Research in 20th Century American Intellectual History
520. Advanced Historical Studies
530. Advanced Historical Studies
590. Supervised Teaching in History
   Individual instruction in the teaching of history under the supervision of a faculty member. For first-year Ph.D. students. (Fall Spring)
591. Reading Course At the PhD Level
   Individual, specialized reading courses; topics, relevant to student’s program, chosen in consultation with faculty member. (Fall Spring)
592. Independent Reading Course
   Individual, specialized independent reading courses; topics, relevant to student’s program, chosen in consultation with faculty member. (Fall Spring)
593. Apprentice Teaching in History
   Apprentice teachers act as participant-observers in an undergraduate course under the close supervision of a member of the faculty. Ordinarily, students will attend the course; hold weekly meetings with the professor to discuss the progress of the course, and, in many cases, consider strategies for teaching the week’s assigned reading, assist the professor in preparing examination questions, paper topics, and other written assignments; gain experience in evaluating undergraduates’ work by reading and commenting on (but not grading) exams and essays; and prepare a lecture or lead a class discussion. (Fall Spring)
595. Research At the PhD Level
   Graduate level research course for the Ph.D. level. (Fall Spring)
895. Continuation of MA Enrollment
897. Master’s Thesis in Absentia
899. Master’s Thesis
985. Leave of Absence
986V. Full Time Visiting Student
990. Summer in Residence
995. Continuation of PhD Enrollment
997. PhD Dissertation
997A. PhD Dissertation in-Absentia
999. PhD Dissertation
Master of Arts in Language Documentation and Description

Language documentation encompasses the collection of naturally occurring as well as experimentally elicited primary data, such as video and audio recordings and written language data; language description uses this and other sources of data to analyze the language. Together, language documentation and description efforts can provide the bases for language grammars, dictionary projects, education and language revitalization materials, and the building of large language corpora. Emerging technologies provide new tools for the analysis of sophisticated language data. The program aims to provide students with the preparation needed to embark on language documentation and description projects and also to be prepared with skills transferable to other fields where the collection and analysis of complex language data may be relevant.

The MA in language documentation and description prepares graduates for language documentation and description projects, as well as for further training at the PhD level; graduates also are equipped with skills transferable to other fields where the collection and analysis of complex language data may be relevant. Language documentation is one of the fastest growing areas of linguistics. For more information, see www.sas.rochester.edu/lin/graduate/LDD.html.

Master of Science in Computational Linguistics

The MS in computational linguistics trains students to be conversant both in the analysis of language and in computational techniques applied to natural language. The curriculum consists of four courses (16 credits) in linguistics and four courses (16 credits) in computer science, for a total of 32 credit hours. Graduates from the MS in computational linguistics are prepared for both further training at the PhD level in computer science and/or linguistics and computational linguistics positions in industry. For more information, visit www.sas.rochester.edu/lin/graduate/MS.html.

PhD Program

Linguistics participates in an interdepartmental PhD program. Students can pursue a PhD with a primary focus in linguistics and a secondary focus in a related field, such as cognitive science, computer science, or other relevant departments.

405. Historical Linguistics

Prerequisite: LIN 110

This course is designed to give an introduction to the principles of linguistic variation and change, and to examine their practical application in the interdisciplinary subfields of historical linguistics and historical sociolinguistics. Topics covered include diachrony and synchrony, genetic relations, the comparative method and language classification, sound change, morphological, syntactic and semantic change, borrowing, types of language contact, areal linguistics, and linguistic variation and social stratification. (Fall)
406. History of the English Lang

407. Old English Literature

410. Introduction to Language Sound Systems
Prerequisite: LIN110

The goal of this course is to provide a background for understanding the principles that underlie the structure of sound systems in human languages. Starting with the notion ‘phoneme,’ the course focuses on acoustic and articulatory phonetics, as a basis for understanding phonological processes and change in linguistic sound forms. Students will acquire skills in the production, recognition, and transcription of sounds in various languages of the world. The course will serve as a foundation for work in language documentation, sociolinguistics and sociophonetics. This course can be taken as LIN 210 or as LIN 410 and is meant for linguistics majors and non-majors alike. (Fall)

416. Speech On the Brain

420. Intro to Grammatical Systems
Prerequisite: LIN110

Syntax is the system of rules that we subconsciously follow when we construct sentences. The course is designed to introduce the grammatical principles that guide the building of structures. The students will acquire and apply the tools necessary for linguistic analysis of phrases and sentences. Built on data puzzles from English and some lesser studied non-Indo European languages, the students will gain insights into state of the art syntactic theory and lingering questions. (Spring)

424. Intro to Computational Ling
Prerequisite: LIN110

This course covers foundational concepts in computational linguistics and is designed for students with a strong background in formal linguistic methods but little or no programming experience. Major focus is placed on deploying techniques used in computational linguistics to advance linguistic theory as well as developing students’ ability to implement these techniques. Topics include basic object-oriented programming in Python, basic formal language theory, probability theory and information theory, finite state phonological and morphological analysis, generative and discriminative models for shallow syntactic and semantic parsing, and bottom-up, top-down, and mixed algorithms for syntactic and semantic parsing. (Spring)

425. Introduction to Semantic Analysis
Prerequisite: LIN110

This course introduces students to the basics of the analysis of meaning in natural language. The first section focuses on devices that motivate certain forms to take on the meanings they have. The second section of the course moves on to discuss how meanings combine to form meanings for larger units—how words and phrases combine to form sentences meanings. Using logical notation we illustrate the formal analysis of natural language meaning in terms of truth-conditions. We will discuss the basics of set theory, and investigate how meanings represented in these terms correlate with the syntactic and lexical structures of sentences of natural language. Students of graduate standing or those with strong formal backgrounds may consider starting with LIN 265/465 instead, for which this course is ordinarily a prerequisite. This course counts towards satisfying the core course requirement for majors. (Fall)

426. Morphology
Prerequisite: LIN110

The course examines the structure and definition of the linguistic unit “word” its typology and the relationship of the morphological component to other levels in the grammar. The course includes an introduction to analytical techniques with emphasis placed on an examination of data from a range of languages. The building blocks of words will be analyzed and topics such as affixation, reduplication and inflectional and derivational morphology will be covered. We will examine the properties of words and how they fit into the larger structure of linguistic knowledge, including the relationship between words and syntactic structure (ex., phrases and sentences) and the relationship between words and phonological structure (ex., phonological rules and prosodic structure). (Fall)

427. Topics Phonetics & Phonology
Prerequisites: LIN 110, LIN 210

This course is intended to provide participants with an overview of research in an area of phonetics and phonology. Issues vary from term to term but may cover areas in segmental, metrical and intonational phonology and the phonology/phonetics interface. This term we will be focusing on the phonological and sociolinguistic aspects of sound change. We will begin with foundational papers in the topic of sound change from both a historical and synchronic perspective. Students will learn about linguistic variation and ongoing change locally in the Inland North dialect area through the analysis of their own interview data. Past and recent studies of the Inland North will provide a framework for learning about the linguistic and social motivations of sound change. (Spring)

428. Lexical Semantics
Prerequisites: LIN 110, and either LIN 210, LIN 220 or LIN 225 or permission of instructor

In this course we investigate the study of word-meaning in current linguistics and cognitive science. We examine the meanings of lexical items such as verbs, nouns, adjectives, and prepositions, and also other categories of words, including various function words and discourse particles. We examine theories of word-meaning, and examine how words and vocabulary may vary between languages.
430. Sign Language Structure

434. Modern English Grammar

447. Natural Language Processing

448. Stats. Speech & Lang Proc

450. Data Science for Linguistics
   Prerequisites: LIN110, and either LIN210, LIN220 or LIN225
   This course addresses linguistic research questions through data science techniques. The course will focus on developing skills to (i) acquire and process a variety of language data, from using established corpora to capturing data in the wild, and (ii) to investigate language use, particularly syntactic and semantic phenomena, through descriptive and inferential statistical techniques. A significant part of the course will be devoted to hands-on projects and will include developing familiarity with using the programming languages Python and R to acquire and explore linguistic data. Familiarity with statistics and/or computational linguistics is advantageous, but not necessary. (Spring)

460. Syntactic Theory
   Prerequisites: LIN 110, LIN 220 or permission of instructor
   This course picks up where LIN 220 leaves off, though focusing more on topics in natural language syntax from a cross-linguistic perspective. The goal of the course is an approach to syntax that accounts for both language-particular as well as universal constraints on language. Among the topics studied are head and phrase movement, constraints on co-reference (anaphora), ellipsis, and agreement (phi features). (Spring)

461. Phrase Structure Grammars
   Prerequisites: LIN110, LIN225, or permission of instructor
   This syntactic theory course examines syntactic phenomena from the perspective of phrase structure and lexicalist grammar as opposed to transformational grammar. The course will examine and develop phrase structure grammar (specifically Head-driven Phrase Structure Grammar) approaches to standard syntactic problems, contrasting them where appropriate with transformational approaches. No background in non-transformational approaches will be assumed. This course can be taken as LIN 261 or as LIN 461 and is meant for linguistics majors and non-majors alike. (Fall)

462. Topics in Experimental Syntax
   Prerequisites: LIN 110, LIN220 or permission of instructor
   This course provides an introduction to experimental methods that can be used to investigate questions that are relevant for syntactic theory. We will discuss a range of methodologies, including self-paced reading, visual world eye-tracking, magnitude estimation and questionnaires. The course will be organized around several topics that have been central to syntactic research, such as anaphor resolution, ellipsis and quantifier scope in order to examine how experimental methods can complement existing work; for example, by shedding light on areas where stable judgments have traditionally been difficult to obtain, and by allowing us to investigate the time course of real-time language processing. By the end of this course students will be able to understand and critically evaluate research that uses various experimental methods, and be able to design and run their own experiments.

465. Formal Semantics
   Prerequisites: LIN110, LIN225 or permission of instructor
   This course is an in-depth introduction to the formal analysis of natural language meaning, employing techniques that have been developed in language and formal philosophy over the last century. Issues include intensionality, quantification, tense, presupposition, plurality, the analysis of discourse, and other current issues. Familiarity with syntax, logic, and/or computation are helpful. (Fall)

466. Introduction to Pragmatics
   Prerequisites: LIN 110, LIN 225
   Within theoretical linguistics, pragmatics is (broadly speaking) the study of how language users convey meaning. This course covers three general areas: (1) How meaning carried by linguistic elements (such as sentences) interacts with meaning that arises from inferences about speakers’ intentions; (2) Ways of characterizing meaning, especially with respect to linguistic elements not easily handled in traditional semantic (i.e., truth-conditional) terms; (3) The role of context in determining meaning. Topics to be discussed include the relation between semantics and pragmatics, representations of context, truth-conditional and other types of meaning, presupposition; implicature and Grice’s Cooperative Principle (Spring)

468. Computational Semantics
   Prerequisites: LIN110, LIN220 or permission of instructor
   This course is a hands-on exploration of recent advances in computational models of meaning. The first part of the course will focus on implementing traditional rule-based compositional semantics in the functional programming language Haskell. We will construct a sophisticated model of formal semantics, culminating in examining the use of monads to model types of natural language meaning phenomena. The second part of the course explores distributional semantic models and their implementation, where lexical meaning is defined in terms of lexical co-occurrence, estimating meaning from large-scale corpus resources. (Fall)

469. Sign Lang Psycholinguistics

470. Tools for Language Documentation
   Prerequisite: LIN110 or permission of instructor
   This is a hands-on class that introduces you to major techniques and tools in language documentation and description. You will learn how to collect and record a variety of language data
through elicitation and text collection. The emphasis is then on organizing, managing, and processing these data sets for various purposes, such as building up a dictionary, annotating natural speech, and time-aligning media of different formats with computational tools such as Praat, ToolBox, and ELAN. Further, we will discuss crucial topics in language documentation such as fieldwork, ethics, and language revitalization. (Fall)

471. Field Methods in Ling Desc I

This class is similar to LIN389: Students will learn how to organize a fieldwork project by working with a native speaker. They will systematically prepare elicitation sessions, organize their data, and learn how to write up short sketches of their findings. The final project is a chapter of a joint sketch grammar of the language, including annotated natural text. In contrast to the senior seminar, however, this course is designed for two terms, continuing in the fall term. Also, participants are required to have taken LIN270/470 as a prerequisite. Having a background in language documentation and data processing techniques, students in this class will focus more on collecting and annotating natural texts (stories, dialogues, experimental data) which is adding a documentary angle.

491. Master’s Reading in LIN

495. Master’s Research in Ling

501. Methods in Linguistic Research

An introduction to the field of linguistics and natural language emphasizing a theoretical perspective. Topics will cover subfields of linguistics, including phonetics, phonology, morphology, syntax, semantics and pragmatics. (Fall)

510. Topics in Phonetics

520. Syntax

This is a graduate class on syntactic theory, focusing mainly on modern transformational approaches (minimalism) to cross-linguistic language structure phenomena. In addition to reading original research leading up to the current state of the art, the course will focus on several case studies (such as pronoun/reflexive reference resolution and ellipsis phenomena) comparing transformational and non-transformational approaches.

525. Graduate Semantics

This course examines a current issue in semantic theory, within the context of a broader theoretical approach to how natural languages meanings are to be analyzed.

527. Topics Phonetics & Phonology

This seminar explores current topics in experimental phonetics and laboratory phonology. These may include speech production, speech perception and their interaction with the phonological grammar, prosody (tone, intonation), metrics and metrical phonology. Including discussion of different phonological theories such as Articulatory Phonology, Intonational Phonology, prosodic morphology, feature theory, segmental theories (vowel harmony systems), as well as user-based approaches to phonology. (Spring)

535. Formal Pragmatics

This seminar explores current topics in pragmatics and its interfaces with other areas including prosody, syntax, semantics. Topics may include implicature, presupposition, at-issueness, speech act theory, information structure, the dynamics of discourse, and the structure of discourse contexts. In addition to discussing recent and classical theoretical works, the seminar aims to incorporate data and theoretical insights from various perspectives including fieldwork on non-English languages, psycholinguistics, and corpus methodologies.

581. Music and Language

This course will explore relationships between musical and linguistic structure. In addition to reading and evaluating early writings on the subject by Bernstein and Lerdahl & Jackendoff, students will assess more recent work by Huron and Patel, and the linguists Hayes and Ladd on prosodic structure. We will also discuss experimental work on prosodic structure in language and on music acquisition in infants. Co-taught by a music theorist and linguist, the course will review basic aspects of phonology, intonational phonology, meter, and memory that are relevant to music. Each student will complete a piece of original research in the form of a term paper and class presentation. Permission of instructor required for non-Eastman students.

590. Supervised Teaching

591. PhD Reading Course in Ling

595. PhD Research in Ling

595A. PhD Research in Absentia

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Master’s Dissertation

899. Master’s Dissertation

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment
Mathematics

Professors Cohen, Gage, Gonek, Greenleaf, Iosevich, Lubkin, Mueller, Pakianathan, Ravenel, Salur, Thakur, Tucker (Chair)
Associate Professors Geba, Haessig, Jochnowitz, Pakianathan

The Department of Mathematics offers the Master of Arts (Plan B), Master of Science in applied mathematics, and Doctor of Philosophy degrees. Applicants are expected to have the equivalent of an undergraduate major in mathematics. This usually includes a year of abstract algebra and a year of real and/or complex analysis.

The MA requires 30 hours of coursework, including MTH 436, 440, 467, 471, or their equivalent. The candidate must also pass an examination based on the courses presented for the degree. The joint MA in mathematics and statistics requires 36 credit hours. (Contact the department for the description and program of study.) Joint MAs with other departments may be arranged on an individual basis.

The MS in applied mathematics requires the following core of mathematical courses: MTH 467, 471. All students enrolled in this program will be required to demonstrate proficiency in a high-level computer language. Students will be able to choose between two options, Plan A or Plan B. Additional credit hours will normally be chosen from graduate courses in mathematics or related technical fields.

The PhD requires a minimum of three years of full-time study, including at least five formal courses at the 500 level, plus preliminary and qualifying examinations and a dissertation. The PhD requires a total of 90 credit hours. Approximately eight 500-level courses are offered each year. The written portion of the qualifying examination covers MTH 436, 437, 440, 453, 467, and 471. The oral portion is devoted to assigned reading from the research literature.

At least three years of supervised college teaching are required for all candidates. Candidates may be excused from part or all of this requirement on the basis of previous teaching experience. Research for the doctoral dissertation usually consumes at least one year.

Foreign students are encouraged to consider the University's English as a Second Language Program, as adequate proficiency in English is necessary for employment as a teaching assistant.

403. Theory of Probability
Prerequisite: MTH 471
Characteristic functions; the central limit theorem; infinitely divisible laws; random walk on groups. (Fall)

436. Algebra I
Prerequisite: MTH 237 or equivalent. Undergrads must have permission of instructor.
Rings and modules, group theory, fields and Galois theory. (Fall)
437. Algebra II  
**Prerequisite:** MTH 436. Permission of instructor required for undergraduates.  
Multilinear algebra, quadratic forms, simple and semi-simple rings and modules. (Spring)

440. General Topology  
**Prerequisite:** MTH 265 or equivalent. Permission of instructor required for undergraduates.  
Continuity; compactness, connectedness, metrizability; product spaces. (Fall)

443. Algebraic Topology  
**Prerequisites:** MTH 436 and MTH 440. Permission of instructor required for undergraduates.  
The combinatorial structure of complexes and the homology of polyhedra; applications of algebraic techniques in topology to classification of surfaces, fixed point theory, and analysis. (Spring)

448. Computational Topology  
**Prerequisites:** MTH 236 and (MTH 265 or MTH 240).  
Computational topology is an emerging field of study at the intersection of mathematics and computer science, devoted to the study of efficient algorithms for topological problems, especially those that arise in other areas of computing. Topics to be covered: algorithms based on higher dimensional topological structures as low dimensional data structure algorithms such as graph algorithms; topology of cell complexes, some graph theory algorithms, homotopy, covering spaces, simplicial homology, persistent homology of large data sets, discrete Morse theory, discrete differential geometry, and normal surface theory. Computing topics may include algorithms for computing topological invariants, graphics and geometry processing, mesh generation, curve and surface reconstruction, VLSI routing, motion planning, manifold learning, clustering, image processing, and combinatorial optimization.

453. Differentiable Manifolds  
**Prerequisite:** MTH 265 or equivalent. Permission of instructor required for undergraduates.  
Differentiable manifolds, mappings and embeddings, exterior differential forms, affine connections, curvature and torsion. Riemannian geometry, introduction to Lie groups and Lie algebras. (Spring)

463. Differential Equations  
**Prerequisite:** MTH 263 or equivalent.  
Classical PDE’s, including the heat and wave equations, with both quantitative and qualitative analysis.

467. Theory Analytic Functions  
**Prerequisite:** MTH 265 or equivalent  
Cauchy theorems, Taylor and Laurent series, residues, conformal mapping, analytic continuation, product theorems. (Spring)

471. Real Analysis  
**Prerequisite:** MTH 265 or equivalent.  
Lebesgue measure on the line; measure spaces; integration; convergence theorems; Radon-Nikodym theorem; differentiation; Fubini’s theorem; function spaces. (Fall)

472. Functional Analysis  
**Prerequisite:** MTH 471  
Banach spaces; dual spaces; Riesz representation theorem; Hilbert spaces; Fourier series; projective and unitary operators; spectral analysis of completely continuous self-adjoint operators. Applications. (Fall)

491. Master’s Readings in Math

492. Special Projects

493. Master’s Essay

503. Theory of Probability  
**Prerequisite:** MTH 471  
Characteristic functions; the central limit theorem; infinitely divisible laws; random walk on groups.

504. Stochastic Processes  

506. Topics in Probability Theory  
Topics are related to recent research in the field. (Spring)

530. Elliptic Curves

531. Top in Alg. Number Theory  
Valuations, ideal theory, divisors. Class number, unit theorem. Geometric applications.

535. Commutative Algebra  
Field theory, valuations, local rings, affine schemes. Applications to number theory and geometry.
537. Commutative Algebra
Prerequisite: MTH 436
Projective and injective modules, complexes and resolutions, derived functors, including Ext and Tor, the homology and cohomology theory of groups and algebras, applications to the extension problem, etc.

538. Topics in Algebraic Geometry
Spaces with structure sheaf, schemes, cohomology of schemes, applications to algebraic curves and algebraic groups.

539. Topics in Algebraic Geom II
Local algebra, applications to intersection theory.

546. Cohomology

547. Topics in Differential Geom.

548. Lie Groups and Algebra
Structure theory of finite dimensional Lie algebras, root-weight systems, Dynkin diagrams, classification of semi-simple Lie algebras and Lie groups and applications. If time permits further topics include p-adic Lie algebras and pro-p groups, finite simple groups of Lie type and knot invariants of Lie type.

549. Topics in Algebraic Topology
I TOPICS: The course will cover the classical theory of fiber/fibre bundles and their associated principal G-bundles with a focus on vector bundles and characteristic classes. If time permits some discussion and applications of K-theory will also be covered. These topics are relatively classical (1950’s and 60’s) but fundamental to much current work in topology, geometry and modern physics. Tentative syllabus below: PREREQS: Prior intro course in algebraic topology and at least simultaneously taking a manifolds course.

550. Topics in Topology
Topics are related to recent research in the field.

555. Topics in Adv. Diff. Geometry
Moving frames, connections, bundles; Gauss-Bonnet theorem and generalizations; theorems of Chern-Lashof; geodesics, Jacobi fields, index theorem.

557. Topics in Differential Geometry
Subject matter to be selected from among advanced copies of current interest in differential geometry and geometric analysis.

562. Fourier Analysis

565. Topics in Partial Differential Equation
Prerequisite: MTH 564
Linear partial differential operators with constant coefficients. Elementary solutions; elliptic, hypo-elliptic, and hyperbolic operators.

568. Topics in Number Theory
This course starts with the definitions and introductory theory of modular forms, presents an overview of some of the classic papers on the subject, and focuses in on some of the recent advances. Particular topics chosen each year are left up to the individual instructor.

569. Topics in Analytic Number Theory
Selected topics in non-multiplicative analytic number theory considered on a seminar basis.

570. Topics in Ergodic Theory & Arithmetic Geometry
An introduction to the probabilistic viewpoint in dynamical systems, and the more recent equidistribution results in arithmetic geometry. After brief overview of ergodic theory and dynamical systems, the course will center on arithmetic heights in dimension 1. The emphasis will be on the intersection of these topics: Arithmetic dynamics. (Fall)

578. Topics in Harmonic Analysis

589. Topics in Inverse Problems

590. Supervised College Teaching

591. PhD Readings in Math

594. Internship

595. PhD Research in Math

595A. PhD Research in Absentia

597. Seminar

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Master’s Dissertation
### Modern Languages and Cultures

#### CHINESE (CHI)

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<th>Course Code</th>
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<td>418</td>
<td>Intro to Chi Pop Culture</td>
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<td>430</td>
<td>Contemporary Chinese Art</td>
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<tr>
<td>433</td>
<td>Chinese Visual Culture: Medium and Materiality</td>
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This course explores the cultural politics of Chinese visual culture through an examination of its mediums. We’ll consider how in pre-20th century China paintings structured relations of gender and of inner and outer worlds; how the inscription of calligraphy on land mediated image and writing, nature and culture; and how the mass production of artworks intersected with conceptions of nature and social organization. We’ll then consider the new media culture of the 1920s-1930s, iconoclasm and idolatry during the Cultural Revolution, and the emergence of experimental and documentary art in recent decades. Our concern will be how mediums, as assemblages of images and surfaces with specific material qualities and practices function within real social spaces and create virtual spaces of representation and imagination.

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<th>Course Code</th>
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<td>435</td>
<td>Photography in East Asia</td>
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<td>437</td>
<td>Chinese Film</td>
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#### COMPARATIVE LITERATURE (CLT)

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<th>Course Code</th>
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<td>402B</td>
<td>Holocaust: Affect and Absence</td>
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<td>Polish and American Poetry</td>
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<td>405</td>
<td>Latin-American Film</td>
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<td>405A</td>
<td>Contemporary French Culture</td>
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This course is designed to provide students with a comprehensive view of French Contemporary culture through major trends of French cultural, political, and intellectual life in the recent years. While we cannot study factual representations of French culture, we will attempt to establish a conceptual framework that would help us in the understanding of complex questions such as What does it mean to be French?, What is France? What is French culture?, etc.

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<td>405B</td>
<td>Francophone Cultures</td>
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Francophone cultures involves the study of discourses produced by the imperial France on the colonized or former Colonized, and the impact of colonization or decolonization in French modern culture. The study of Francophone texts introduces students to one of the most dynamic aspect of “Cultures in French.”
The course will finally, in the light of multiculturalism, attempt to look at ways and means that might lead to a better understanding of France’s standing in the World today. By exposing students to a broad range of ideas, to the relativity of all cultural representations, this course hopes to introduce them to the complexities of cultural diversity and to challenge stereotypical perceptions of French culture.

**408A. Traditional Jpn Culture**

An overview of Japan’s traditional culture through the most prominent examples of its visual, literary, and performing arts, with attention to the social contexts of aesthetic experience and to ideas of a “national culture.” Taught in English, additional work available in Japanese where appropriate.

**408C. Contemporary Jpn Culture**

**409. On Genealogy**

**409B. Russian Identity**

**410. Miyazaki & Ghibli**

A course on the work of the animated films of Hayao Miyazaki, the world view and visual sensibilities of his creation, Studio Ghibli, and anime as film form and cultural phenomenon. Focusing on Miyazaki’s films, we will examine the “nuts and bolts” of animated cinematic construction (use of narrative space, character design, etc.); methods of adaptation, influence, and genre variation; anime reception and fan culture; and issues of race, gender, landscape, identity and cultural conscience. Such detailed analysis reveals the range and possibilities of anime and its place in popular culture on a local and global scale.

**410B. Power of Popular Culture**

**411B. French Cinema: the New Wave**

**411C. History of French Cinema**

**411D. Contemporary French Film**

**411E. Filming/Writing Postcol Women**

This course will explore the Postcolonial Woman Condition in films and novels produced by African and Caribbean female directors and writers. Capturing the complex destinies of African and Caribbean women, challenging the machismo that is inscribed in cultural and social fabrics of their communities, exploring creative and daring venues that may mobilize energies for women liberation are constitutive of postcolonial women filmmaking and writing traditions, from the framing of the deferred dream or the Saaraba poetics to the Community-oriented camera. The course interrogates the paradoxes of the African filmmaking/writing traditions, especially its reliance on western expertise and languages, financing and sometimes audiences to exist. From diasporic connections to street children, from anticolonial struggles to postcolonial disillusionments, from genital mutilations to AIDS, from incest to rape, this course is addressed to students of French studies, Women studies and Film studies.

**411F. Classical Film Theory**

**411G. Feminist Film Theory**

**411J. Films of Jean-Luc Godard**

**411M. French in Film**

**412A. Monsters, ghosts & Aliens**

This course focuses on the horror genre as popular entertainment in Germany, England, and the US in the 19th and 20th centuries. Particular attention will be paid to the construction of “others” as monsters in literature and film (Frankenstein, Vampires, Devils, Aliens, etc.). Authors/filmmakers include: Hoffmann, Poe, Shelley, Stoker, Jackson, Rice, Harris, King, Murnau, Jordan, Wise, Siegel, Kubrick, Demme. This course is part of the Horror in Literature & Film Cluster.

**412C. New German Cinema**

In this course we will explore representations of women in post-World War II German cinema. Moving chronologically from the building of two German states to the post-unification period, we will consider the constantly shifting meaning of woman in popular and avant-garde films, narrative and documentary films, films by both male and female directors. We will consider equally films from East and West Germany. How does woman function as a narrative device in these films? Do women behind the camera change, woman’s meaning within the film? Can woman consistently be reduced to one narrative trope (mother, comrade or whore), or does she resist? All readings and discussions are in English; all films are subtitled.

**412H. Fairy Tales, Myths & Legends**

Grimm’s fairy tales to urban legends, this course will examine the stories we love to tell ourselves. They horrify us and, yet, strangely comfort us as well. What is it that causes this effect? How do these tales help us shape the world around us? This course is part of the Humanities cluster “Horror in Literature and Film.” It is designed to familiarize students with the tools of cultural studies.

**412L. Cinema & Revolution**

This course will explore the relationship between film and revolution in West German cinema from 1965 to the present. We will consider cinema’s potential as a revolutionary medium, while also focusing on how revolution is thematized and constructed in both fiction and documentary films. The course will engage with issues such as coming to terms with the fascist past, recreating the cinema as a revolutionary artistic form, feminism as a
revolutionary perspective, the domestic sphere as a revolutionary space, and the co-optation of the cinema's revolutionary potential through mass consumption.

**412M. Hollywood Behind the Wall: An Introduction to East German Cinema**

This course will explore major developments in the East German cinema, including issues such as coming to terms with the fascist past, popular filmmaking and art cinema, cinema as a pedagogical tool, artistic dissent and state censorship, socialist ideologies of gender, and the politics of documentary. Each film will be explored in relation to its socio-historical context, providing students with an overview of East German film and culture.

**413B. Cities & the Country in Mod Ch**

Explores changing cultural meanings of country and city from early 20th century urban culture through revolution and to the present era of mass migration and urban destruction and renewal.

**414A. Tourist Japan**

**414B. Mobsters, Monsters & Swords**

**414C. Akira Kurosawa**

**414E. Japanese Animation**

**414G. Japanese New Wave Cinema**

**414H. Nagisa Oshima:**

**414M. Atomic Creatures: Godzilla**

Origins and development of the Japanese kaiju eiga (monster film): nuclear imagery and the science fiction/horror/creature film genre.

**414N. Tourist Japan**

**415A. Russia Goes to Movies**

**416A. Mexican Film**

**416B. Spanish Film**

**416C. Women in Hispanic Film**

**417. Men of Marble, Women of Steel: An Introduction to East European Film**

This course will provide a general introduction to the history, artistry and politics of East European film. We will begin by considering the place of East European film in the context of contemporary film studies and the industry structure of state socialist film making. We will then explore individual films from a regional (not national) perspective, considering how they confront issues such as the burden of history and ethics, the tensions between modernity and tradition, the struggle between creativity and censorship, as well as the reluctant feminism of state socialism and representations of gender and sexuality.

**417B. Race & Gender in Pop Film**

**419. Weimar Culture**

**421. Mutilated Bodies**

‘Transnational sisterhood’ or cultural imperialism? Legitimate ritualized practice or outdated violent ritual? Genital cutting, female circumcision, female genital surgery? The controversy over this practice already begins with the act of its naming. If there seems to be a consensus about the physical violence imposed on the female body, why is it that western feminist discourse is suspected of perpetuating the mutilation African voices? This course seeks to provide an understanding of the context in which a fragmented ‘transnational sisterhood’ allows for a proliferation of mutilated discourses on mutilated postcolonial bodies. Readings and Films include Alice Walker (Warrior Marks), Florence Ayissi Fauziya Kassindja (Do They Hear You When You Cry), Maryse Conde and more critical and theoretical readings from African, French and North American authors. In English.

**422A. Sexuality and Gender: 18th Century Representation**

This course explores 18th century conceptions/constructions of the body, sexuality, and gender as manifest in medical papers, handbooks, aesthetic essays, and literary works to include Lessing’s Laocoon and Philotas, Fielding’s The Female Husband, Defoe’s Moll Flanders, Cleland’s Fanny Hill, de Sade’s Justine, Goethe’s Gotz von Berlichingen, Kleist’s Holy Cacelia and Puppet Theater, Diderot’s The Nun, Shelley’s Frankenstein. Additional theoretical readings include: Foucault, Kristeva, Butler, Sedgwick, Gilman, Habermas, Cassirer, Todorov, Laqueur, and G.S. Rousseau.

**422B. Gender & Sexuality**

This course will examine literary, artistic, and theoretical representations of gender and sexuality as they have changed in the course of the 20th Century. The focus will be on texts from Western Europe and the US, but we will also consider other perspectives. From the New Women to French Feminists and transnational feminism. From homophile societies to ‘queer nation and gay marriage, from Sigmund Freud to Michel Foucault and Judith Butler, we will explore the contested and politically charged debates around gender and sexuality that have shaped our views of identity over the last century.

**422C. Gender Love & Families**

**423. And Now... Deep Thoughts With German-Jewish Thinkers!**
424A. Japanese Women Writers

424B. Modern Jpn Women Writers

426D. Gender in Spanish-Amr Lit
Prerequisite: SP 200 for SP 260 only
Through study of texts (mostly novels) written by women from Spanish America, we will ask broad questions concerning cultural contexts with respect to sexuality and gender, language, aesthetics, psychology, and social issues. The course will use materials from a variety of fields (literary and cultural theory, history, sociology, anthropology, feminist studies) in addition to the primary texts. Emphasis on collaborative research and progressive writing assignments. Campus visit by one of the authors planned. Class taught in English.

427. Body Politics

428. Brazilian Lit and Culture

429. Colonial Latin American Lit

430. Film as Object

430A. French Social Thought
This course examines the singular contribution of French thinkers to the development of the social sciences (or the “sciences of man,” as they are known in France) in the twentieth century. We will examine the theory of gift exchange in Marcel Mauss, the rise of structural anthropology in Claude Lévi-Strauss, the sociology of Pierre Bourdieu, and the theories of religion and culture of René Girard and Marcel Gauchet. We will also study post-structuralist thinkers such as Jacques Derrida and Jean-Luc Nancy when their work touches on issues of society and religion. Taught in English.

This course is a study of the Francophone African Novel from North Sub-Saharan African, and from Madagascar. The course will explore the political and cultural contexts that gave rise to the modern African literature in general, and to the modern African Novel in particular.

431B. Madness & Post Colonial Lit
This course will explore inscriptions of madness in post-colonial African and Caribbean texts. Beyond the obvious and visible signs of what is generally termed “madness” (from the pathological to the political or cultural), we will ask ourselves if the post-colonial arena cannot be interpreted as a pervasive manifestation of madness, that is to say, of something fundamentally “alien, foreign” to the Known, to the imperial destructuring order, and to the disarticulated colonial and post-independent communities. By bringing together texts from different and diverse cultural and intellectual areas such as France, Guadeloupe, and Africa, we seek to confront the various “scriptures.” Issues of witch-hunt, of disintegration of Juletane, the Antillean women in West Africa, from Foucault’s normative panopticism to Fanon’s discussion of the black experience, the postcolonial situation, articulated or silenced, will be the focus of this course. Taught in English.

431F. Foucault & Ethics

432. Jewish Writer & Rebel

433. Medium & Materiality in Chi

435. Texts Beyond Borders

436B. US Latinos/Latinas
Introduction to U.S. Latino/a writing and culture in its rich geographic and ethnic diversity; Latinization of the American landscape; exile, immigration, cultural syncretism.

437. Gender & Sex in 20th Century

438. Contemporary Poetry

439. Representing Afr-Americans

440. German Jews
Jews have lived in Germany since the Middle Ages and have contributed a great deal to German Culture, as well as developing unique German Jewish cultures; these facts are often overshadowed by the tragic events of World War II. In this seminar we will explore the rich and diverse German Jewish cultures of nineteenth and twentieth centuries in a range of texts including fiction, travel texts, philosophical and historical writings. Topics will include the Haskalah (Jewish Enlightenment), assimilation, Zionism, anti-Semitism and the relationship between East and West European Jews. Readings and discussions in English.

441. Caribbean Novel & Theory

441A. Performance Studies
Study of major authors of the French Enlightenment, as well as their predecessors and contemporaries, including Marivaux, Montesquieu, Voltaire, Prevost, Rousseau, Diderot, Sade, and Laclos.

441H. The Francophone Novel
A survey of the Francophone literary world (Quebec, North Africa, Central Africa, the Caribbean, etc.) in an effort to identify traits and common characteristics of these regions. We will attempt a critical analysis of selected works by well-known Francophone writers and their portrayal of issues such as poverty, religion, culture, politics and the impact of France assimilation.
441. Caribbean Novel & Theory
This course is a study of major Caribbean novels and major theoretical texts. The reading will be structured around the notion of “Antillanite” or Creolization elaborated by Martinican Edouard Glissant and his heirs Chamoiseau and Confiant of the “Creolite” movement. The controversial presence of the Other (Africa and France) in the Caribbean, the need to build a Caribbean authenticity in order to participate freely in what Glissant Glissant terms “Relation planetaire” (Planetary Relations) will also be thoroughly examined.

441M. The Early European Novels
442A. Poe & Hoffmann
This course explores the beginnings of the horror and detective genres in the 19th century. Particular attention is devoted to the narrative structure, tropes, and psychological content of the strange tales by Poe and Hoffmann. Theories of horror are also addressed to include discussions by Lessing, Todorov, Huet, and Kristeva. Note: this course is taught in English

443. Wizards, Magic and Fantasy
This course traces the development of the fantasy literature genre from ETA Hoffmann's The Golden Pot to JK Rowling’s Harry Potter series. Particular attention is devoted to the tropes and structures of fantasy narratives as they offer the reader an escape from a mundane or threatening world and provide intricate social critiques. Topics addressed include: wizards, witches, talking cats, flights of fantasy, new worlds, and social constructions of work, class, others, families, mothers, fathers, masculinity, femininity etc. Authors include: Hoffmann, Rowling, Shelley, Orwell, Tolkien, Kafka, Atwood etc.

446B. Facing Facts: non-Fictn Wrtng

447. Theory & Practice of Comedy

448. On the Move: trav,wandrns & Expl
This course covers a wide variety of texts in which mobility plays a central role, including films, cultural theory and fiction. The time period we cover will be from the nineteenth century to the present day. Some of the questions we will explore are: What are the reasons people move from one place to another? Who controls the movement and how? How do texts allow us as viewers and readers travel? Texts and discussions are in English.

449. Dungeons & Dragons: Myths and Legends in German Literature
With the recent revival of Wagner’s Ring Cycle at the Metropolitan Opera in New York City, the continued popularity of J.R.R. Tolkien’s Lord of the Rings novels and recent film adaptations of Beowulf and Tristan and Isolde, it’s easy to see that people still regularly like to “get medieval”. In this course we’re going to look at the German origins of these modern texts by reading the original source material: The Nibelungenlied, Parzival, Tristan as well as many other important medieval works. We will also look at modern variations on those texts, from Wagner and Tolkien to modern role-playing and video games that use the medieval period as their settings.

450. Nabokov
451. Strangers in A Strange Land
452. Bright Lights, Big City
The city in film and literature is never just a physical space - discourses of modernity and urban life are mapped onto real and imaginary urban spaces. In this course we will explore how the relationship between the spaces of the city and the stories told about and through them shape our understanding of urban life. Some of the texts we will examine are: Fritz Lang's M, Arthur Schnitzler’s Dream Story, and Lloyd Bacon’s 42nd Street.

452A. Kafka & His World
This course explores the weird, dreamlike, eerie, and inexplicable world of Kafka’s writings. In Kafka’s stories dogs conduct investigations, apes report to academies, men turn into bugs, the Statue of Liberty holds up a sword, and arrests occur without explanation as all expectations and assurances about the “rules” of existence, thought, and social order come into question. In this course we will read texts such as: The Trial, The Metamorphosis, Amerika, The Castle, Investigations of a Dog, A Report to an Academy, In the Penal Colony, and A Hunger Artist. This course is taught in English.

454C. Japanese Science Fiction
454D. Jpn Mystery Fiction
455A. Great Russian Writers
455C. Chekhov and the Modern Short Story
456. Germany Year Zero
458. Middle Eastern Cinema
460. Truth & Power
461. Philosophy of Art
462. Visual & Cultural Studies
462C. Japanese Women Writers
464A. The Culture of Zen
464B. Modern Jpn Lit
465B. Russia Goes to Movies

466. Napoleon Image, myth, History
Course examines the image of Napoleon at the intersection of myth and history. Literary portrayals, paintings, and films. Con
ducted in English.

467. Author: anx of Infl

471. Contemporary Asian Art

472. Fassbinder

473. French Cinema 1930-1960

475. French Philosophy Since 1960

477. Modern Jpn Lit in Trans

478. Hello Kitty Must Die: Japanese Popular Culture in Global Contexts

479. Immigration in French Literature and Film

480. Aesthetics

481A. Contemporary French Thought
This course is a survey of the major intellectual movements of the twentieth century. Beginning with Ferdinand de Saussure and the study of the linguistic sign, we move on to consider cultural anthropology and the invention of structuralism. Finally, the course takes a detailed look at Derridean deconstruction, the movement that has influenced so much Anglo-American criticism, and we conclude with a brief foray into other forms of poststructuralism.

481B. Psychoanalysis & Literature
How does literature “think”, and what does it think about? Why are so many literary texts about love, death, and/or people finding out about who they are? Reading literature with psychoanalytic theory, we will discuss the formation of subjectivity, perspective, the gaze, and love and death; we will ask how literature communicates things that no other form of language can.

482. Freud and Psychoanalysis

482A. Marx & Marxism
It is not overstated to say that the works of Karl Marx have provided the transformational impulse to many of the changes of the 20th century. Who was this person, Karl Marx? Why is it that in this post-Cold War world his writings continue both to inspire and threaten contemporary readers? How have those inspired by Marx further developed his ideas to constitute the discourse of Marxism? In this course we will begin with discussions of key works by Marx. We will then move on to examine some significant contributions to Marxism. Additionally majors and minors can sign up for GER 211 where significant texts will be read and discussed in German.

482B. Nietzsche & Nietzscheans
Friedrich Nietzsche continues to be one of the most influential modern philosophers, yet controversy surrounds almost every aspect of his life and work. This course will help students go beyond the controversy in order to consider Nietzsche’s texts discerningly and how he approached the problems of truth, power, and morality. Close examination of his most important writings will be complemented by inquiry into Nietzsche’s effects on twentieth-century philosophy. Other thinkers include Martin Heidegger, Michel Foucault, Sarah Kofman, Jacques Derrida and Giles Deleuze.

482C. Freud and Psychoanalysis
Freud is one of the most influential thinkers of the 20th century. His ground-breaking work on dreams, the Oedipus Complex, and psychoanalytic method have profoundly changed our understanding of the psyche and social interaction. This course provides a basic survey of Freud’s most important and often controversial writings/discoveries within their historical context and with regards to significant criticisms of his work. “Freud: An Introduction” is part of a cluster which includes courses of Marx and Nietzsche (these courses need not be taken in any particular order) Additionally majors and minors can sign up for GER 211 where significant texts will be read and discussed in German.

482D. Strangers

483. Sartre & Heidegger
This course studies two of the most influential works in twentieth-century philosophy: Martin Heidegger’s Being and Time (1927) and Jean-Paul Sartre’s Being and Nothingness (1943). Together these two books defined existential phenomenology and changed the course of philosophy, exerting a profound influence over later writers and thinkers. Since both philosophers sought to fundamentally redefine human subjectivity—its place in society, history, and the philosophical tradition—we will examine concepts such as freedom, reality, temporality, subjectivity, death, emotion, and the relation between self and other. We will also compare Sartre’s insights with those of Heidegger, particularly in regard to the concept of humanism, juxtaposing Sartre’s famous manifesto “Existentialism is a Humanism” (1946) with Heidegger’s critique of Sartre and French existentialism in his “Letter on Humanism” (1947).

484. Translation and World Literature

486. New Austrian Cinema

487. Studies in Translation
488. New German Cinema
489. Major Seminar
491. Reading Course in Comp Lit
492. Photo in Sp & Sp America
495. Master’s Research in Comp Li
496. New Austrian Cinema
591. PhD Reading Course
592. Language Learning and Teaching I
The purpose of this six-week course is to prepare foreign lan-
guage teaching assistants an understanding of second language
learning and the current teaching methods used in foreign lan-
guage classrooms. The course highlights the communicative ap-
proach to teaching language in which reading, speaking, listen-
ing and writing are integrated into the language learning process.
Through experiential learning experiences, that included peer
and instructor feedback, teaching assistants will learn to develop
meaningful and culturally relevant lessons.

593. Language Learning & Teaching II
This course is a continuation of Languages, Learning, and Teach-
ing I. Teaching assistants will develop and implement authentic
materials/lessons that reflect the lives of their students. Students
will also develop an understanding of long term planning and
assessment. TAs will continue to receive and provide corrective
feedback on lesson plans and lesson demonstrations as a means
to build confidence and effective teaching methods.

595. PhD Research
595A. PhD Research in Absentia
890. Summer in Residence - MA
895. Cont of Master’s Enrollment
899. Masters Dissertation
985. Leave of Absence
986V. Full Time Visiting Student
990. Summer in Residence
995. Cont of Doctoral Enrollment
997. Doctoral Dissertation
997A. Doct Dissertatn in Absentia
999. Doctoral Dissertation
999A. Doct Dissertatn in Absentia

FRENCH (FR)

404. Contemporary French Culture
This course is designed to provide students with a comprehensive
view of French Contemporary culture through major trends of
French cultural, political, and intellectual life in the recent years.
While we cannot study factual representations of French culture,
we will attempt to establish a conceptual framework that would
help us in the understanding of complex questions such as What
does it mean to be French?, What is France? What is French
culture?, etc.

405. Francophone Cultures
Francophone cultures involves the study of discourses produced
by the imperial France on the colonized or former Colonized,
and the impact of colonization or decolonization in French
modern culture. The study of Francophone texts introduces stu-
dents to one of the most dynamic aspect of “Cultures in French.”
The course will finally, in the light of multiculturalism, attempt
to look at ways and means that might lead to a better under-
standing of France’s standing in the World today. By exposing
students to a broad range of ideas, to the relativity of all cultural
representations, this course hopes to introduce them to the
complexities of cultural diversity and to challenge stereotypical
perceptions of French culture.

411. Aspects of Fr Grammar
Close analysis of selected texts, not so much for their content
as for their grammatical interest. Discussion and practice of ad-
vanced topics; some attention to practical phonetics.

412. French Literature in Translation

420. 18th Century Novel
Study of major authors of the French Enlightenment, as well
as their predecessors and contemporaries, including Marivaux,
Montesquieu, Voltaire, Prevost, Rousseau, Diderot, Sade, and
Laclos.

425. Origines Du Roman Francais
When-and why-did people become hooked on reading novels?
What was it about this particular literary form, which only hit
its stride as recently as the late seventeenth century, that caused
it to outstrip all other kinds of literary and cultural production?
And furthermore, why were novels considered so scandalous
that religious and political authorities actually tried to prevent
young women from reading them? In this course, we’ll look at
the origins of the French novel up through the middle years of
the nineteenth century. We will be concerned with, in addition
to the issues raised above, questions of realism, of licentiousness, and of the novel’s social function. Authors will include Mme de Lafayette, Diderot, Prevost, Balzac, and Flaubert. Course conducted in French.

426. Reason and Scandal
Early modern France was for centuries governed and controlled through fear, convention, oppression, and superstition. The Age of Enlightenment produced thinkers who challenged tradition authority and suggested models for independent reasoning, empirical thought, and, perhaps most radically, human equality. While their works persist today as models of the power of independent thinking, the battles were hard won: most of the writings of authors such as Voltaire, Diderot, Rousseau, Montesquieu, Mme de Graffigny, and the marquis de Sade met with harsh critical condemnation. This course will examine the birth of modern forms of reason in eighteenth-century France and its connections to scandal, outrage, and hostility.

427. Laughing Matters
430. French Social Thought
432. Hugo’s Les Miserables
This course examines one of the world’s greatest and most influential novels, Victor Hugo’s Les Miserables (1862). We will interpret Hugo’s novel as a modern epic that incorporates the genres of the historical novel, the realistic novel, and the popular novel. The vast and multifaceted canvas of Hugo’s novel will allow us to discuss issues of social justice, moral philosophy, religion, politics, history, the city of Paris, and love. We will also study some of the many screen adaptations that have been made of the book. Conducted in French.

433. Realists & Romantics
434. Paris: capital of the 19th C
Course studies how Paris became the archetypal modern city. Examination of literary forms specially attuned to depicting the new urban realities, such as the realistic novel and Baudelaire’s poetry, as well as paintings, illustrations, and photographs. Hassmann’s spatial and architectural transformation of the city during the second half of the 19th century. Walter Benjamin’s writings on Paris analyzed in light of recent work by cultural historians. In English.

435. Texts Beyond Borders
437. Performance Studies
438. Romantic Orientalism
This course studies the way in which the “orient” (North Africa, the Middle East, Persia) was represented in the literature and painting of French Romanticism. Analysis of Edward Said’s famous thesis concerning the West’s “orientalism” against the backdrop of nineteenth-century French colonialism. Authors studied include Chateaubriand, Hugo, Gautier, Nerval, Baudelaire, Flaubert. Paintings by Delacroix, Ingres, Gérôme, Fromentin, Vernet. In French

439. Representing Afr-Americans
440. Le Roman Francais
This course looks at the history of the French novel, from its early history in the late 17th century, through the philosophic and great realistic traditions of the 18th and 19th centuries, and up to and including recent works of fiction. We will study the form and function of the novel, as well as the narrative structures and forms of verisimilitude that authors chose to develop. Authors will include Mme de Lafayette, Voltaire, Diderot, Flaubert, Robbe-Grillet, and others. Readings and class discussion primarily in French.

441. Le Nouveau Roman
442. Theatre Francais
443. Mutilated Bodies
‘Transnational sisterhood’ or cultural imperialism? Legitimate ritualized practice or outdated violent ritual? Genital cutting, female circumcision, female genital surgery? The controversy over this practice already begins with the act of its naming. If there seems to be a consensus about the physical violence imposed on the female body, why is it that western feminist discourse is suspected of perpetuating the mutilation African voices? This course seeks to provide an understanding of the context in which a fragmented ‘transnational sisterhood’ allows for a proliferation of mutilated discourses on mutilated postcolonial bodies. Readings and Films include Alice Walker (Warrior Marks), Florence Ayissi Fauziya Kassindja (Do They Hear You When You Cry), Maryse Conde and more critical and theoretical readings from African, French and North American authors. In English.

444. Classical French Stage
445. Revolution & Romanticism
446. Count of Monte Cristo
449. Napoleon Image, myth, History
Course examines the image of Napoleon at the intersection of myth and history. Literary portrayals, paintings, and films. Conducted in English.

454. Camus & Sartre
455. Sartre & Heidegger
This course studies two of the most influential works in twentieth-century philosophy: Martin Heidegger’s Being and Time (1927) and Jean-Paul Sartre’s Being and Nothingness (1943). Together these two books defined existential phenomenology and changed the course of philosophy, exerting a profound influence over later writers and thinkers. Since both philosophers sought to fundamentally redefine human subjectivity—its place in society, history, and the philosophical tradition—we will examine concepts such as freedom, reality, temporality, subjectivity, death, emotion, and the relation between self and other. We will also compare Sartre’s insights with those of Heidegger, particularly in regard to the concept of humanism, juxtaposing Sartre’s famous manifesto “Existentialism is a Humanism” (1946) with Heidegger’s critique of Sartre and French existentialism in his “Letter on Humanism” (1947).

462. French Philosophy Since 1960

464. Contemporary French Thought
This course is a survey of the major intellectual movements of the twentieth century. Beginning with Ferdinand de Saussure and the study of the linguistic sign, we move on to consider cultural anthropology and the invention of structuralism. Finally, the course takes a detailed look at Derridean deconstruction, the movement that has influenced so much Anglo-American criticism, and we conclude with a brief foray into other forms of poststructuralism.

465. Aesthetics

466. Balzac & Baudelaire

467. Baudelaire: Fleurs Du Mal

468. Jean Renoir and Cinema

469. Foucault and the Ethics of Theory

472. Madness & Post Colonial Lit
This course will explore inscriptions of madness in post-colonial African and Caribbean texts. Beyond the obvious and visible signs of what is generally termed “madness” (from the pathological to the political or cultural), we will ask ourselves if the post-colonial arena cannot be interpreted as a pervasive manifestation of madness, that is to say, of something fundamentally “alien, foreign” to the Known, to the imperial destructuring order, and to the disarticulated colonial and post-independent communities. By bringing together texts from different and diverse cultural and intellectual areas such as France, Guadeloupe, and Africa, we seek to confront the various “scripts.” Issues of witch-hunt, of disintegration of Juletane, the Antillean women in West Africa, from Foucault’s normative panopticism to Fanon’s discussion of the black experience, the postcolonial situation, articulated or silenced, will be the focus of this course. Taught in English.

473. The Francophone Novel
A survey of the Francophone literary world (Quebec, North Africa, Central Africa, the Caribbean, etc.) in an effort to identify traits and common characteristics of these regions. We will attempt a critical analysis of selected works by well-known Francophone writers and their portrayal of issues such as poverty, religion, culture, politics and the impact of France assimilation.

474. Caribbean Novel & Theory
This course is a study of major Caribbean novels and major theoretical texts. The reading will be structured around the notion of Antillanité or Creolization elaborated by Martinican Edouard Glissant and his heirs Chamoiseau and Confiante of the Creolité movement. The controversial presence of the Other (Africa and France) in the Caribbean, the need to build a Caribbean authenticity in order to participate freely in what Glissant Glissant terms Relation planetaire (Planetary Relations) will also be thoroughly examined.

475. Psychoanalysis & Literature
How does literature “think”, and what does it think about? Why are so many literary texts about love, death, and/or people finding out about who they are? Reading literature with psychoanalytic theory, we will discuss the formation of subjectivity, perspective, the gaze, and love and death; we will ask how literature communicates things that no other form of language can.

This course is a study of the Francophone African Novel from North Sub-Saharan African, and from Madagascar. The course will explore the political and cultural contexts that gave rise to the modern African literature in general, and to the modern African Novel in particular.

479. Immigration in French Literature and Film

480. French Cinema: the New Wave

481. French Cinema 1930-1960

483. Contemporary French Film

484. Filming/Writing Postcol Women
This course will explore the Postcolonial Woman Condition in films and novels produced by African and Caribbean female directors and writers. Capturing the complex destinies of African and Caribbean women, challenging the machismo that is inscribed in cultural and social fabrics of their communities, exploring creative and daring venues that may mobilize energies for women liberation are constitutive of postcolonial women filmmaking and writing traditions, from the framing of the deferred dream or the Saaraba poetics to the Community-oriented camera. The course interrogates the paradoxes of the African filmmaking/writing traditions, especially its reliance on western
expertise and languages, financing and sometimes audiences to exist. From diasporic connections to street children, from anticolonial struggles to postcolonial disillusionsments, from genital mutilations to Aids, from incest to rape, this course is addressed to students of French studies, Women studies and Film studies.

486. Growing Up in French
What does it mean to grow up in French without being French? What is the price to pay for children confronting a language and culture that are alien but necessary for any social mobility? How is French (language and culture) transformed by bilingual cultural contexts and subjects? This course explores autobiographical novels and stories by Francophone authors growing up in a context dominated by the French language and culture. Taught in French.

488. French in Film

489. Philosophy of Art

490. History of French Cinema

491. Master’s Readings in French

495. Master’s Research in French

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

899. Master’s Dissertation

985. Leave of Absence

990. Summer in Residence

GERMAN (GER)

404. Marx & Marxism

405. Nietzsche & Nietzscheans
Friedrich Nietzsche continues to be one of the most influential modern philosophers, yet controversy surrounds almost every aspect of his life and work. This course will help students go beyond the controversy in order to consider Nietzsche’s texts discerningly and how he approached the problems of truth, power, and morality. Close examination of his most important writings will be complemented by inquiry into Nietzsche’s effects on twentieth-century philosophy. Other thinkers include Martin Heidegger, Michel Foucault, Sarah Kofman, Jacques Derrida and Giles Deleuze.

406. Freud and Psychoanalysis
Freud is one of the most influential thinkers of the 20th century. His ground-breaking work on dreams, the Oedipus Complex, and psychoanalytic method have profoundly changed our understanding of the psyche and social interaction. This course provides a basic survey of Freud’s most important and often controversial writings/discoveries within their historical context and with regards to significant criticisms of his work. “Freud: An Introduction” is part of a cluster which includes courses of Marx and Nietzsche (these courses need not be taken in any particular order) Additionally majors and minors can sign up for GER 211 where significant texts will be read and discussed in German.

409. On Genealogy

411. Jewish Writer & Rebel

412. Monsters, ghosts & Aliens
This course focuses on the horror genre as popular entertainment in Germany, England, and the US in the 19th and 20th centuries. Particular attention will be paid to the construction of “others” as monsters in literature and film (Frankenstein, Vampires, Devils, Aliens, etc.). Authors/filmmakers include: Hoffmann, Poe, Shelley, Stoker, Jackson, Rice, Harris, King, Murnau, Jordan, Wise, Siegel, Kubrick, Demme. This course is part of the Horror in Literature & Film Cluster.

414. Fairy Tales, Myths & Legends
Grimm’s fairy tales to urban legends, this course will examine the stories we love to tell ourselves. They horrify us and, yet, strangely comfort us as well. What is it that causes this effect? How do these tales help us shape the world around us? This course is part of the humanities cluster “Horror in Literature and Film.” It is designed to familiarize students with the tools of cultural studies.

415. Berlin: Tales of A City

416. Dungeons & Dragons: Myths and Legends in German Literature
With the recent revival of Wagner’s Ring Cycle at the Metropolitan Opera in New York City, the continued popularity of J.R.R. Tolkein’s Lord of the Rings novels and recent film adaptations of Beowulf and Tristan and Isolde, it’s easy to see that people still regularly like to “get medieval”. In this course we’re going to look at the German origins of these modern texts by reading the original source material: The Nibelungenlied, Parzival, Tristan as well as many other important medieval works. We will also look at modern variations on those texts, from Wagner and Tolkein to modern role-playing and video games that use the medieval period as their settings.

418. And Now... Deep Thoughts With German-Jewish Thinkers!

419. Weimar Culture
420. Sex & Gender: 18th C Rep
This course explores 18th century conceptions/constructions of the body, sexuality, and gender as manifest in medical papers, handbooks, aesthetic essays, and literary works to include Lessing’s Laocoon and Philotas, Fielding’s The Female Husband, Defoe’s Moll Flanders, Cleland’s Fanny Hill, de Sade’s Justine, Goethe’s Gotz von Berlichingen, Kleist’s Holy Caecilia and Puppet Theater, Diderot’s The Nun, Shelley’s Frankenstein. Additional theoretical readings include: Foucault, Kristeva, Butler, Sedgwick, Gilman, Habermas, Cassirer, Todorov, and G.S. Rousseau.

421. Gender, Love, and Families

429. Kafka & His World
This course explores the weird, dreamlike, eerie, and inexplicable world of Kafka’s writings. In Kafka’s stories dogs conduct investigations, apes report to academies, men turn into bugs, the Statue of Liberty holds up a sword, and arrests occur without explanation as all expectations and assurances about the “rules” of existence, thought, and social order come into question. In this course we will read texts such as: The Trial, The Metamorphosis, Amerika, The Castle, Investigations of a Dog, A Report to an Academy, In the Penal Colony, and A Hunger Artist. This course is taught in English.

430. Poe and Hoffmann: Uncanny Stories
This course explores the beginnings of the horror and detective genres in the 19th century. Particular attention is devoted to the narrative structure, tropes, and psychological content of the strange tales by Poe and Hoffmann. Theories of horror are also addressed to include discussions by Lessing, Todorov, Huet, and Kristeva. Note: this course is taught in English.

431. German Jews
Jews have lived in Germany since the Middle Ages and have contributed a great deal to German Culture, as well as developing unique German Jewish cultures; these facts are often overshadowed by the tragic events of World War II. In this seminar we will explore the rich and diverse German Jewish cultures of nineteenth and twentieth centuries in a range of texts including fiction, travel texts, philosophical and historical writings. Topics will include the Haskalah (Jewish Enlightenment), assimilation, Zionism, anti-Semitism and the relationship between East and West European Jews. Readings and discussions in English.

434. Strangers in A Strange Land

437. After the Wall

446. Walking On Your Head: writing Vertigo in German Lit and Philosophy
Beginning in the 18th century a new question arises with regard to the subject’s orientation in thought. However, almost as soon as this orientation has taken place, its double, vertigo, appears as a pathological inversion of the overly subjective interpretation of truth. This double, which haunts the last two centuries of thought, ultimately empties the subject of all content. Although this de-centering of the subject does produce a compensatory relief from certain social constraints, it is not always easily controlled. In this course we will read a series of texts that deal with this problem of vertigo.

447. Holocaust: Affect and Absence

448. On the Move: trav,wandr&s & Expl
This course covers a wide variety of texts in which mobility plays a central role, including films, cultural theory and fiction. The time period we cover will be from the nineteenth century to the present day. Some of the questions we will explore are: What are the reasons people move from one place to another? Who controls the movement and how? How do texts allow us as viewers and readers travel? Texts and discussions are in English.

449. Bestsellers of the New Gen
This course explores the surging popularity in Germany of short stories and novels written by young women writers of the New Generation. These literary works strive to depict contemporary German lifestyles and particularly those of young people in cities like Berlin. Class taught in German.

452. Bright Lights, Big City
The city in film and literature is never just a physical space - discourses of modernity and urban life are mapped onto real and imagined urban spaces. In this course we will explore how the relationship between the spaces of the city and the stories told about and through them shape our understanding of urban life. Some of the texts we will examine are: Fritz Lang’s M, Arthur Schnitzler’s Dream Story, and Lloyd Bacon’s 42nd Street.

456. Germany Year Zero

460. Truth & Power

461. Weimar Film & Film Theory

462. Strangers

472. Gender & Sexuality
This course will examine literary, artistic, and theoretical representations of gender and sexuality as they have changed in the course of the 20th Century. The focus will be on texts from Western Europe and the US, but we will also consider other perspectives. From the New Women to French Feminists and
transnational feminism. From homophile societies to “queer nation and gay marriage, from Sigmund Freud to Michel Foucault and Judith Butler, we will explore the contested and politically charged debates around gender and sexuality that have shaped our views of identity over the last century.

475. Digital Cityscapes
478. Weimar Culture
482. Fassbinder

483. Cinema & Revolution: West German Avant-Garde
This course will explore the relationship between film and revolution in West German cinema from 1965 to the present. We will consider cinema as potential as a revolutionary medium, while also focusing on how revolution is thematized and constructed in both fiction and documentary films. The course will engage with issues such as coming to terms with the fascist past, recreating the cinema as a revolutionary artistic form, feminism as a revolutionary perspective, the domestic sphere as a revolutionary space, and the co-option of the cinema’s revolutionary potential through mass consumption.

484. Hollywood Behind the Wall: An Introduction to East German Cinema
This course will explore major developments in the East German cinema, including issues such as coming to terms with the fascist past, popular filmmaking and art cinema, cinema as a pedagogical tool, artistic dissent and state censorship, socialist ideologies of gender, and the politics of documentary. Each film will be explored in relation to its socio-historical context, providing students with an overview of East German film and culture.

485. Men of Marble, Women of Steel: An Introduction to East European Film
This course will provide a general introduction to the history, artistry and politics of East European film. We will begin by considering the place of East European film in the context of contemporary film studies and the industry structure of state socialist film making. We will then explore individual films from a regional (not national) perspective, considering how they confront issues such as the burden of history and ethics, the tensions between modernity and tradition, the struggle between creativity and censorship, as well as the reluctant feminism of state socialism and representations of gender and sexuality.

486. New Austrian Cinema
488. New German Cinema

It is common now to hear that we live in a transnational age, but what does this really mean? How do we imagine our transnational community? In this course we will examine contemporary transformations from national to trans-national culture by focusing precisely on film production. This course will examine how film provides one of the central sources of transnational images. Germany will provide us with a case study and we will view a wide variety of German and European, national and transnational films. Through this case study we will address larger questions of globalization. Through hot new cult films like “Run, Lola Run,” or big budget epics like “House of the Spirits,” we will examine the aesthetic and technical transformations that have given rise to these new ways of imagining our community. Please note: Attendance at weekly film screening is mandatory -- alternative time will be set up.

491. Master’s Reading in German
492. Practicum
495. Master’s Research in German
584. Hollywood Behind the Wall
588. Mothers, Comrades & Whores
890. Summer in Residence - MA
895. Cont of Master’s Enrollment
899. Master’s Dissertation
985. Leave of Absence
990. Summer in Residence

JAPANESE (JPN)

407. Film as Object
411. Modern Jpn Lit in Trans
412. Hello Kitty Must Die: Japanese Popular Culture in Global Contexts
414. Atomic Creatures: Godzilla
Origins and development of the Japanese kaiju eiga (monster film): nuclear imagery and the science fiction/horror/creature film genre.

414W. Atomic Creatures: Godzilla
419A. Tourist Japan
427. Body Politics
433. The Culture of Zen
446. Contemporary Jpn Culture
454. Modern Jpn Lit

457. Jpn Mystery Fiction

458. Japanese Science Fiction

467. Contemporary Asian Art

474. Modern Jpn Women Writers

483. History of Japanese Cinema

Japanese cinema from its origins to the 1960s: genre, narrative, diversity of style, theory, and technology; the visual image in a social, cultural and historical context.

485. Director Studies: Akira Kurosawa

The films of Akira Kurosawa, his co-workers, and the contemporary issues and aesthetic influences important to his career.

494. Hayao Miyazaki and Planet Ghibli

A course on the work of the animated films of Hayao Miyazaki, the world view and visual sensibilities of his creation, Studio Ghibli, and anime as film form and cultural phenomenon. Focusing on Miyazaki’s films, we will examine the “nuts and bolts” of animated cinematic construction (use of narrative space, character design, etc.); methods of adaptation, influence, and genre variation; anime reception and fan culture; and issues of race, gender, landscape, identity and cultural conscience. Such detailed analysis reveals the range and possibilities of anime and its place in popular culture on a local and global scale.

498. Contemporary Japanese Cinema

Japanese cinema’s engagement with its contemporary context, focusing on reworking and reinterpreting familiar genres and Japanese cinema’s significance in the global marketplace.

SPANISH (SP)

405. Spain Past Present Future

This course explores the history of social and cultural development of modern Spain into the 21st century through a variety of media such as art, literature, and film. Topics range from the early cultural life of the peninsula to the implications of the Reconquista and from Spain’s overseas empire to the Spanish Civil War, some emphasis on contemporary issues. Class taught in Spanish. Several papers, midterm exam. All written work in Spanish.

406. Invention Sp America

This course explores the ideas and events shaping the culture(s) of Spanish America, from pre-Columbian times to the present, with an emphasis on the concepts of discovery, conquest, mestizaje, and the formation of national cultural identity. Strong consideration will be given to contemporary issues. Texts will be drawn from literature, sociology, anthropology, history, the arts, and film. Several short essays, two exams. Class taught in Spanish.

417. El Quijote

A close reading of both parts of the novel, with special attention to how the Spanish work anticipates and prepares the major modes of expression of later Western prose fiction. Each student will be asked to interpret a major 18th, 19th, or 20th-century fiction on the basis of Cervantes’s book. Classroom presentations, written assignments, and exams. Class taught in Spanish.

418. Saints, Sinners & Sovereigns

420. Golden Age Drama

A study of the theatrical masterpieces of Lope, Tirso, and Calderon, which rank with the greatest Western drama, with particular attention to their comedic uniqueness. Class taught in Spanish.

431. The Generation of 1898 and Modernismo

Prerequisite: SP 200

In both Spain and Latin America the closing years of the nineteenth century and the dawning of the twentieth demanded critical revisions in the areas of politics and aesthetics. Intellectuals—writers, artists, and musicians alike—confronted the “ruins” of the past, seeking in their place new expressions of sublime beauty, liberty, spirituality and sensuality. Revision or destruction? Tradition or innovation? Nationalism or “Enlightenment”? Woman as angel or demon, muse or serpent? From Nicaraguan Ruben Dario to Cuban Jose Marti, and in Spain, from Valle-Inclan to Unamuno, this course explores the creation of the “fin de siglo” subjectivity in its multiple forms during the “decadent” transition from the “old” to the “new.” 2-3 short papers; exam. Class taught in Spanish.
449. Topics in Spanish Lit & Cult
Prerequisite: SP 200

Topics vary and may include the Spanish sonnet and romance, Cervantes' novelas ejemplares, the arts and the Spanish Civil War, and other considerations of the relations between literature and other disciplines (the visual arts, philosophy, history, music, etc.). Class taught in Spanish.

449A. Stories From Spain
Prerequisite: SP 200

This course examines a variety of realist novels, psychological thrillers, erotic tales, heroic narratives, and coming-of-age tales from XIX, XX and XXI century Spain. In discussions we will look at social changes - the Spanish Civil War, the death of Franco, the Constitution of 1978, women's rights movements - autonomous regional politics, the destape, the Movida, and Spain in the New Europe - through the literary reflections of social issues, aesthetics, and political debates. Course taught in Spanish. All written work in Spanish.

449B. Stages of Resistance

449D. Bunuel, Dali, Lorca
Prerequisite: SP 200

In the decades preceding the Civil War, Spanish avant garde is represented by three larger-than-life figures: exiled film director Luis Buñuel, obsessed with the feminine, with his homeland and its supposedly eternal myths; Federico García Lorca, poet and playwright of Andalucía and its mythified past, assassinated on the eve of the conflict; and Salvador Dali who lives the tenets of both Surrealism and capitalism in the flesh. Each leaves a legacy that extends beyond the borders of Spain and beyond the end of the twentieth century. This course explores Surrealism and Spain, from the 1920s on, embedding cutting-edge works in broader questions of identity and possible threats to an emerging nation in a continent, a world, and an ethos caught between tradition and modernity. Includes films, art, essays, plays, poetry. Course taught in Spanish.

449E. Reading Fables Telling Tales

This course will examine the rich tradition of short stories and fábulas in Spain, beginning in medieval times and ending in the eighteenth century. We will examine the different ways in which a story can be presented as well as the purposes (didactic, entertainment, etc.) behind a variety of shorter works produced. Some of the themes that will be addressed are: exemplarity, love, social class, marriage, revenge, gender and miracles. We will also consider the shift from an oral culture to a written one and the implications of the invention of the printing press and rising literacy rates on the short story as a genre and reading as a pastime. Special emphasis will be placed on the Novelas ejemplares by Miguel de Cervantes and the Desengaños amorosos by María de Zayas. Other authors include the Arcipreste de Hita, Don Juan Manuel and Tomás de Iriarte. In Spanish.

449G. Princesas, Prisioneras

456. Contemp Span-Amer Prose

457. Sp Am the and Poetry

Spanish America has long been home to internationally renowned poets, while theater has seemed to languish in the background. This course juxtaposes the often private, hermetic language of poetry with the public genre of theater to discover aesthetic and ideological connections and disparities. Readings chosen from the major works of Alfonso Storni, Roberto Arlt, Pablo Neruda, César Vallejo, Jorge Díaz, Luis Rafael Sánchez, Octavio Paz, Sabina Berman and others. Several brief textual commentaries, two essays, two exams. Class taught in Spanish.

459. Hispanic Women & Globalization
Prerequisite: SP 200 for SP 259 only

Radical social and economic changes occurring in the twenty-first century reinforce the need for better cultural and historical perspectives on women's roles and activities in Latin America. This course examines Latin American women intellectuals, activists, and feminists in the context of 'Third World' perspectives. The roles of women in 'Third World' countries have been affected greatly by drastic social, economic, and cultural changes over the past decades. How do they see themselves? What role does immigration play in their lives? We examine the ideas of intellectuals, politicians, and the popular classes in Latin America regarding their own societies and the U.S. Includes photographic, cinematic, and written texts. Individual and group research projects. Issues of sexuality, education, the family, work, and culture will be considered in readings, films, and videos, art and music, and in conversations with guest speakers. Two to three papers. Class taught in English.

460. Spanish American Women Writers
Prerequisite: SP 200 for SP 260 only

Through study of texts (mostly novels) written by women from Latin America, we will ask broad questions concerning cultural contexts with respect to sexuality and gender, language, aesthetics, psychology, and social issues. The course will use materials from a variety of fields (literary and cultural theory, history, sociology, anthropology, feminist studies) in addition to the primary texts. Emphasis on collaborative research and progressive writing assignments. Campus visit by one of the authors planned. Class taught in English.

461. Facing Facts: non-Fictn Wrtng
Prerequisite: SP 200 for SP 261 only

This course will ask the following questions: How have Spanish American writers constructed factual, truth-telling texts? What
impact has photography had on the writing of nonfiction? What expectations do we as readers bring to documentary literature? How are the lines drawn -- and blurred -- between factual and fictional discourses? Readings will be chosen to represent revolutionary Mexico, labor struggles of the 1920s, revolutionary Cuba, the repression in the Southern Cone, the Central American insurgencies, and the survival of indigenous cultures. Short essays; research term paper. Class taught in English.

462. Colonial Latin American Lit
Prerequisite: SP 200

Topics vary from semester to semester. Possible topics include the confessional mode in Hispanic literature, surrealism and the avant-garde in art and Hispanic literature, Mexican literature, and other areas of interdisciplinary study. Class taught in Spanish.

462B. Cuba At A Crossroads

Now that the twenty-first century has arrived, we cannot help but picture a Cuba “without Fidel.” But what does that mean? How do those in Cuba imagine their nation down the road? How does the Cuban community in Miami represent its hopes and dreams? This course examines art, film, and literary texts from the “homeland” and from the diaspora to compare and contrast images that negotiate between the past and the future. Course taught in English. Readings may be done in English or Spanish (for SP credit).

462C. Disabling Discourse: Disability in Spanish-American Literature

462D. Culture & Lit of the Caribbean

462F. Identity Signs

This course will examine a variety of 20th-Century Spanish-American literary texts that represent the young person’s search for identity, self-knowledge and a place in an often hostile society. Factors such as nationality, social class, gender, race, ethnicity and sexual orientation make this a dynamic process that is fraught with tensions and contradictions. Authors may include: María Luisa Bombal, José María Arguedas, Mario Vargas Llosa, Rosario Ferré, Nelson Estupinan Bass, José Augustín, Isabel Allende, Elena Poniatowska and Rosamaría Roffiel. This course will be taught in Spanish.

466. Brazilian Lit and Culture

470. Hispanic Short Story

471. Power of Popular Culture

472. Postcards From Spain

475. Marx and Freud

477. Mexico, Df: Global Metro

Called by some “the capital of the 21st century,” Greater Mexico City is inhabited by close to 20 million people. The Distrito Federal (DF) and capital of Mexico is today the largest metropolitan area in the western hemisphere and third largest city in the world by population. Established by the Spanish in 1524 on the ruins of the Aztec city Tenochtitlán they had destroyed, Mexico City is a global center of finance, culture, and industry. This course examines the development of this vibrant megalopolis over the 20th and 21st centuries using literature, film, politics, tourism, music and the arts, cultural geography, architectural space, and essays by urban wanderers to try and get a handle on a space that seems to contradict itself at every turn.

480. Transhisanic Supernatural

481. Other Worlds & Underworlds

482. US Latinos/Latinas

Introduction to U.S. Latino/a writing and culture in its rich geographic and ethnic diversity; Latinization of the American landscape; exile, immigration, cultural syncretism.

485. Bunuel & Co.

487. Latin-American Film

487A. Mexican Film
Prerequisite: SP 200 for SP 287A only

Visitors to Mexico already have Hollywood versions of the country in their heads, but the ‘real’ Mexico is a much more complex place. Archetypes of tough hombres, renegade outlaws, dark and sultry women, or beach bums lolling under the hot sun fall by the wayside when Mexican cinema introduces the grittier and much more varied realities of the contemporary nation. This course explores both historical antecedents and contemporary visions. It includes films by directors such as Spanish exile Luis Bunuel, Alejandro González Inarritu, Jaime Humberto Hermosillo, Alfonso Cuaron, Carlos Reygadas, Raul Ruiz, Maria Novaro, and other box office favorites. From Robert Rodriguez’s Bedhead, to Desperado, Once Upon a Time in Mexico and, of course, Y tu mama tambien, Entre Pancho Villa y una mujer desnuda, and La ley de Herodes we explore images of Mexican culture. Course taught in English but work may be written in Spanish for Spanish credit.

488. Spanish Film

489. Women in Hispanic Film

491. Master’s Readng Course in Sp

492. Photo in Sp & Sp America

495. Master’s Research in Sp
Music


425. Seminar in Rock Music
Prerequisite: Grad students studying Theory or Musicology
Devoted to specialized topics in Rock Music

431. Music Analysis: Musicals

434. Music Analysis: the Beatles
Prerequisites: MUR 211, TH 201, or the equivalent.
This course is designed for upper-level undergraduate music majors and graduate students in music. We will analyze the music of the Beatles in detail, focusing on issues of form, harmony, textural coordination/stratification, lyrics, instrumentation, rhythm/meter, and production. (Spring)

435. Progressive Rock in the 70s
Prerequisite: By permission of instructor only
Seminar course designed for graduate/advanced undergraduate music students having a strong background in music history and analysis. Closely examining music of 1970s progressive rock bands, with emphasis on Yes, Genesis, King Crimson, Emerson Lake & Palmer, and Gentle Giant. Students will transcribe passages, closely analyze, and consider music in terms of issues of form, texture, harmony, melody, instrumentation, as well in relation to a variety of music-historical and aesthetic contexts. (Fall)

436. Music, Ethnography, and HIV/AIDS
Prerequisites: Instructor Permission Student should describe interest in music study, ethnography, HIV/AIDS, completed music, anthropology, public health, African Studies, gender studies, or other related coursework.
Addressing the devastating effects of HIV/AIDS in the United States, United Kingdom, Tanzania, Zimbabwe, Uganda, Haiti, and elsewhere, this uniquely interdisciplinary course will incorporate insights from the fields of public health, medical anthropology, and ethnomusicology. Studying the HIV/AIDS epidemic through the lens of musical expression, we will ask how individuals and communities affected by HIV/AIDS have mobilized musical sound in response to the disease. Topics addressed within the class will include musical representations of HIV/AIDS within queer communities; the use of music in public health campaigns to raise awareness about the disease; and the mobilization of musical performance within grassroots support groups for individuals affected by HIV/AIDS. (Spring)

468. West African Drumming Intro
See course description for MUR 168A.
Philosophy

Professors Conee, Curren (Chair), Feldman, FitzPatrick, Modrak
Associate Professors Audi, Dees
Assistant Professors Clatterbuck, Peterman
Joint Appointment: Professor Carlson

The Department of Philosophy offers a program of study leading to the degree Doctor of Philosophy. It emphasizes training for scholarly research and teaching in ethics, epistemology, metaphysics, philosophy of science, history of philosophy, and logic. The department cooperates with the Departments of Computer Science, Brain and Cognitive Sciences, and Linguistics in a graduate program in cognitive science. A detailed description of these programs may be obtained upon request from the department.

Prior to starting work on a dissertation, all candidates for the PhD are required to complete the foundations requirement and the concentration requirement. The foundations requirement, to be completed by the end of the third semester, requires nine graduate level courses, including one in logic, one in the history of modern philosophy, and one in the history of Ancient Greek Philosophy. The concentration requirement includes six advanced courses followed by a comprehensive exam in each of a student’s two concentration areas. All students are required to take one semester of PHL 581 and most spend several semesters as a teaching assistant. The MA degree is awarded upon completion of eight graduate courses and one comprehensive examination.

When a student has completed all of the PhD requirements noted above, he or she may petition the department to conduct the qualifying examination.

412. Prob, Inference & Decision
This course will investigate the logic and metaphysics of probability and its applications to various philosophical and scientific problems. This course will not require math beyond simple algebra.

414. Logical Methods
Prerequisite: PHL 110 or equivalent
Introduction to formal syntax and semantics, applied to modal logic, tense logic, free logic, subjunctive conditionals; elementary introduction to set theory.

415. Intermediate Logic
Prerequisite: PHL 110 or equivalent
Whereas in a standard introductory logic course, students learn how to do proofs within a formal logical system, in this course, students learn how to do proofs about formal logical systems. The main goal is to learn how to prove the soundness and completeness of different sorts of logical systems. Along the way, other important results in Proof Theory and Model Theory are considered.
416. Mathematical Logic  
**Prerequisite: PHL 110 or permission of instructor.**  
This is a course on metalogic and computability, building up to Godel’s incompleteness theorems. The course explores what is and is not possible when it comes to formalizing arithmetic in standard first-order logic. It introduces concepts of proof, satisfaction, decidability, primitive recursion, computability, and others.

420. Recent Ethical Theory  
**Prerequisite: One previous course in ethics.**  
The course will be a study of the work of major twentieth-century philosophers on fundamental questions in ethics, such as: What is really meant by value terms like “good”, “evil”, “right”, and “wrong”? How could we ever know what has value and what we morally ought to do? Are there any universally applicable ethical norms, or is morality subjective or otherwise relativized? Readings from Moore, Ross, Ayer, Stevenson, etc. This course may be taken for upper-level writing credit. (Spring)

421. Philosophical Foundations of American Revolution  
**Prerequisite: One previous course in philosophy or permission of instructor.**  
Philosophical foundations of the American Revolution by examining the political theory which lies behind the revolution itself and which underlies the foundations of the Constitution, while keeping an eye at the historical contexts that shaped the philosophy. We will begin by looking at the important predecessors to the revolution, particularly the works of John Locke, Montesquieu, and David Hume. We will then consider important works from the period surrounding the revolution, including works by Thomas Paine and Thomas Jefferson. Finally, we will look at the debates surrounding the adoption of the U.S. Constitution, including the Federalist Papers and important anti-Federalist works.

423. Social & Political Philosophy  
**Prerequisite: PHL 102 or permission of instructor**  
An inquiry into the nature of human society, the role of the state, and relation of moral to legal obligations.

424. History of Ethics  
**Prerequisite: One previous course in philosophy.**  
A study of the theoretical thinking about ethics throughout history. The primary emphasis is on Western figures, such as Socrates, Plato, Aristotle, Augustine, Aquinas, Hume, Kant, Mill, Nietzsche.

426. Philosophy of Law  
**Prerequisite: One previous course in Philosophy.**  
This course will examine the nature of law in common law legal systems. It will proceed historically, beginning with Aquinas, mentioning Blackstone, examining Bentham and Austin, mentioning Gray, examining Holmes, Hart, and Dworkin. Topics emphasized will include the relation between Law and Morality, the nature of legal interpretation, with emphasis on the role of precedent in common law, the nature of legal rules, and the issue of the completeness of law. Written work will include two short (ca. 5 pages) papers, mid-term, final exam, and periodic quizzes. Regular class attendance is expected. (Spring)

428. Public Health Ethics  
**Prerequisite: One previous course in philosophy.**  
Examines the values of health, social needs, and freedom through a systematic examination of situations in which these conflicts arise. Public health ethics lie at the intersection of medicine, political philosophy, and public policy.

429. Philosophy of Education  
Theories and controversies about the nature and aims of education; boundaries of educational authority; educational adequacy, equality, and justice; learning, inquiry, knowledge, and critical thinking; the measurement of learning; moral and civic education; patriotism, evolution, and sex in the curriculum.

430. Environmental Justice  
**Prerequisite: One previous course in Philosophy.**  
Environmental justice and sustainability, both domestic and global, bringing philosophical and systems analysis to bear on environmental degradation, transparency and governance, climate change, the ethics of consumption and development, responsibility to future generations. (Spring)

442. Metaphysics  
Investigates topics in contemporary metaphysics, including questions about the existence and persistence conditions of abstract and material objects; the nature of space and time; the possibility of time travel; the status of quantum mechanics. No prior courses in science required.

443. Theory of Knowledge  
The course examines some classic and contemporary themes in epistemology. The topics typically include the nature of knowledge and justification, the merits of skeptical arguments about the external world and induction, and recent work about disagreement and rationality. The graded work typically includes essay question tests and short to medium length papers on issues discussed in the course. (Fall)

444. Philosophy of Mind  
An introduction to classic and contemporary problems in the philosophy of mind, this course investigates how the mind is related to the physical world. Topics include: What is the mind and how is it related to the brain? How is it possible for mental states to cause physical states, and vice versa? How do mental...
states get their intentional content? What is consciousness and can it be given a physical explanation? What are the minds of other beings - such as animals and artificially intelligent computers - like, and how could we know?

447. Philosophy of Language
The goal of the course is to examine a number of central philosophical problems about language (including the nature of linguistic meaning and its relation to truth, reference, communication, and necessity), while exploring the connections between these problems and issues in and about philosophy more generally.

449. Formal Semantics
This course is an in-depth introduction to the formal analysis of natural language meaning, employing techniques that have been developed in language and formal philosophy over the last century. Issues include intensionality, quantification, tense, presupposition, plurality, the analysis of discourse, and other current issues. Familiarity with syntax, logic, and/or computation are helpful but not necessary. See Linguistics 265. (Spring)

452. Philosophy of Science

454. Philosophy of Cognitive Sci
Prerequisite: PHL 110 or permission of instructor.
This course is an introduction to the philosophy of cognitive science. Possible topics include the structure of cognition; theories of mental representation; explanation and reduction in cognitive science; folk psychology and theory of mind; and evolutionary psychology. While not assumed, it is recommended that students first take Philosophy of Mind, Minds and Machines, or at least one class in Brain and Cognitive Sciences. This course may be taken for upper writing level credit. (Spring)

456. Darwin & Religion
Prerequisites: One previous course in philosophy, religion, or a natural science. Only one (PHL/BIO/REL 256 or BIO 109) can be taken for credit
Equal parts science, history, and philosophy, this course will examine the interaction between science and religion, especially as it pertains to Darwin’s theory of evolution. Through primary and secondary readings, students will investigate: whether the relationship between science and religion has been primarily one of conflict or harmony; how religious context influenced both the formulation and acceptance of Darwin’s theory; whether evolution is incompatible with common religious views; and the ongoing relevance of Darwinism to debates over the relationship between science and religion. These questions will be explored in part through an examination of Darwin’s own evolving scientific, philosophical, and religious views. This course is reading-intensive and discussion-based.

465. Selected Topics in Ancient Philosophy: Foundations
The course addresses central topics in ethics, metaphysics and epistemology and philosophy of mind in PreSocratic, Platonic, Aristotelian and Hellenistic philosophy.

468. Selected Topics in Medieval Philosophy
This course is a focused study of selected philosophers, topics or traditions from the medieval period (from 300 CE through 1450 CE) in Europe, Northern Africa and Western Asia. Figures may include philosophers such as Augustine, Boethius, Aquinas, Ockham, Scotus, Suarez, Marguerite Porete, Ibn Sina, Al-Ghazali and Maimonides.

470. Selected Topics in Modern PHL
Prerequisite: PHL 202- History of Modern Philosophy or equivalent background in early modern philosophy is a prerequisite.
In this course, we will focus on selected figures, topics and positions from the modern period of philosophy - about 1500 to 1800. This semester’s topic will be Kant’s Critique of Pure Reason.

491. Master’s Readings in PHL
493. Master’s Essay
495. Master’s Thesis Research

502. Formal Epistemology
We will study two or three leading recent issues in epistemology. Possibilities include the problem of easy knowledge, the possibility of rational peer disagreement, the relevance of practical considerations to knowledge, experimental epistemology, how knowledge is valuable, and the nature of evidence. (Spring)

503. Theory of Knowledge

516. Sel Top PHL of Language
This seminar is devoted to current issues in philosophy of language. Recent topics have included possible worlds, relativism, truth, propositions, deontic and epistemic modality.

517. Sel Top Ethics
Critical exploration of work in contemporary metaethics and normative ethical theory and its applications.

518. Sel Topics in Moral Epist

519. Top in Mod Phil: Leibniz
A study of the 17th century philosopher Leibniz, focusing on metaphysics.

520. Sel Top in Political Phil
521. Aristotle Seminar
Covers central issues and topics in Aristotle's philosophical writings. The topic to be discussed in a specific semester is determined by the instructor and announced in advance.

522. Plato Seminar
Addresses central issues and topics in Plato's dialogues. The topic to be discussed in a specific semester is determined by the instructor and announced in advance. (Spring)

527. Sel Topics in Modern PHL
Seminar focused on a topic or figure from early modern philosophy.

530. Kant

542. Special Prob in Metaphysics
An intensive discussion of the nature of time and change, with the particular aim of reconciling eternalist endurantism with a certain realist view of properties. (Spring)

544. Topics in Phil of Mind

552. Selected Topics in PHL Sci

560. Writing Seminar
Study of recent articles; writing short commentaries, replies, criticisms. Covers various topics under guidance of several faculty members. (Fall Spring)

580. Supervised Instructn in PHL
Supervised teaching of undergraduates, including leading discussion sections, grading tests and papers, and meeting with students. (Fall Spring)

581. Supervise Instruct:lec to Un
Continuation of PHL 580, with practice lecturing to the undergraduate classes. (Fall Spring)

591. PhD Readings in PHL

594. Internship

595. PhD Research in PHL

595A. PhD Research in Absentia

890. Master's Summer in Residence

895. Cont of Master's Enrollment

897. Master's Dissertation

899. Master's Dissertation

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

999. Doctoral Dissertation

999A. Doct Dissertatn in Absentia
Physics and Astronomy

Professors Bigelow, Blackman, Bodek, Cline, Das, Demina, Douglass, Eberly, Ferbel, Forrest, Frank, Gao, Hagen, Manly, McFarland, Melissinos, Orr, Quillen, Rajeev, Shapir, Slattery, Teitel, Thorndike, Watson (Chair), Wolf, Wolfs

Associate Professor Garcia-Bellido

Assistant Professors BenZvi, Ghoshal, Gourdain, Nichol, Oakes

Joint Appointments: Professors Agrawal, Betti, Bocko, Boyd, Collins, Foster, Guo, Knox, McCrory, Ren, Rothberg, Schröder, Sobolewski, Stroud, Tarduno, Thomas, Zhong;

Associate Professors Dery, Yamivakas; Assistant Professors Franco, Froula, Rygg

Professors of Research Howell and Mamajek


The Department of Physics and Astronomy offers a graduate curriculum leading to a PhD degree in physics and in physics and astronomy. MS degrees (under Plan A) and MA degrees (under Plan B) are awarded only in physics. The entire program of research and study is designed to emphasize fundamental physical principles and to prepare students for academic, industrial, or government employment. The department has strong research efforts in experimental/observational and theoretical areas of astronomy and astrophysics, biological physics, condensed matter physics, high energy/elementary particle physics, mathematical physics, nuclear physics, plasma physics, and atomic, molecular, and optical physics (quantum optics).

The observational astrophysics group is active in the development of advanced detector arrays and instrumentation for space- and ground-based infrared astronomy. Several faculty are involved in space-astrophysics missions such as the NASA Spitzer Space Telescope and Near-Earth Object Camera (NEOCam), and the ESA Herschel Space Observatory. The astrophysics groups use a wide range of ground-based observatories operating across the electromagnetic spectrum and belong to the SMARTS consortium of small remotely operated telescopes. They employ these facilities in observational studies of protostellar evolution and star formation, in protoplanetary disk evolution and planet formation, and in the search for nearby young stars and their planetary systems.

The Theoretical Astrophysics group explores a wide range of phenomena in astrophysical sources from the sun to the most distant active galaxies. As many of the sources in the universe contain magnetized fluids or plasma, the themes of hydrodynamics, magnetohydrodynamics (MHD), and plasma astrophysics have played a role in the department's theoretical research programs. With computational and analytical approaches, the group explores such issues as the origin of magnetic fields, interstellar clouds and galaxies, accretion disks, the roles of mass outflows and magnetism in the formation and death of stars, and the physics of active galactic nuclei. The group is also actively pursuing new directions of research in planetary dynamics, protoplanetary disks, and planet formation. With colleagues in Rochester's Department of Earth and Environmental Sciences, the group also investigates the history of Earth's magnetic field and the origin of planetary magnetism, by study of palaeomagnetism in terrestrial and meteoritic rocks.

The plasma astrophysics/physics group and the Laboratory for Laser Energetics (LLE) have also combined their resources and talents to create a new program in High-Energy Density Laboratory Astrophysics. The use of high-energy density devices like Inertial Confinement Fusion (ICF) lasers for investigations of cosmic environments is a new development in astrophysics, which holds great promise. Increased collaborations between astrophysicists and plasma scientists are essential for progress in this new field and together University of Rochester astro/plasma physicists and LLE scientists are pushing the frontiers of recreating the Universe's most exotic phenomena.

Research in several areas of biological and medical physics is carried out in the department. Faculty from the School of Medicine and Dentistry with appointments in physics conduct research in advanced techniques in magnetic resonance imaging (MRI) and in various forms of optical spectroscopy and fluorescence imaging, the latter primarily in the context of photodynamic therapy of cancer. Current work in MRI includes diffusion-weighted imaging of the brain and intermolecular multiple-quantum coherence. Other active research areas represented through joint faculty appointments are charge transport in DNA and biomolecular sensing.

Experimental research in condensed matter physics includes surface physics and interfaces of organic semiconductors, ultrafast dynamics of photoexcited electrons, superconducting electrons, optical properties of nanostructures and low-dimensional semiconductors, solid-state cavity quantum electrodynamics, solid-state quantum information, photophysics of organic materials, superconductor electronics, and solar cells. Theoretical work focuses in the areas of statistical mechanics and critical phenomena, interface growth, vortex dynamics in superconductors, quantum coherence, as well as electronic structures in inorganic and organic materials.

The particle and nuclear physics groups explore a diverse array of research areas centered on the goals of determining the nature of the fundamental constituents of matter, how these constituents interact, and the role they play in the evolution of the Universe. The group has a large role in energy frontier physics, which builds upon a history of achievement at the Tevatron Collider at the Fermi National Accelerator Laboratory and which is currently working on detecting and analyzing the first collisions from the Large Hadron Collider at CERN in Geneva Switzerland. A second major experimental focus is neutrino physics, with programs at Fermilab and J-PARC designed to understand the properties of neutrinos and their role in the early universe. The group also has experimental programs in nuclear structure (Argonne and Lawrence Berkeley Lab); gravitational wave detection (LIGO); electron scattering on nuclei (Jefferson Lab), direct searches for dark matter (SURF); and development of accelerator technologies for the creation of low emittance beams for proton storage rings and future electron linear colliders. The particle and nuclear theory group studies a broad range of topics from formal theoretical and mathematical physics, to calculations applied to measurements being produced in today's experiments. Current work centers on understanding the gauge theories of the weak and strong interactions, the discovery potential of future accelerators, and fundamental problems in quantum field theories.
An active research program in quantum optics covers both theory and experiment. Research topics include quantum imaging, slow/fast light, the coherence properties of electromagnetic fields, spectroscopy with partially coherent sources, the concept of single-photon phase, quantum entanglement, and the interaction between light and atoms including the domain of superstrong laser fields and the single-photon quantum limit. In addition there are also active studies of elementary processes involving photons and atoms, tests of quantum locality violations, quantum information imaging and communication, revivals and quantum interference in atomic and electronic wave packets, sub-Doppler laser cooling and ultraslow atom collisions, and Bose-condensation.

High-speed computers at the University are available for use as an adjunct to both experimental and theoretical research. The department maintains its own state-of-the-art computing network for research and administrative needs. The department’s Barnes Computer Center, staffed by two full-time systems managers, provides a convenient central location for department computing equipment. A large public workroom provides workstations, access to the network, Macintosh computers, optical scanning, and color printing. Access is available 24 hours a day. The facilities of the department contain, in addition to research and office space for both staff and graduate students, an up-to-date departmental library.

The cross-disciplinary physics program, and department policy allow students with special interests in the research of faculty members outside the department to obtain a PhD in physics under such external supervision. Theses have been completed in this way in areas of mathematics, biology, optics, electrical engineering, chemistry, and plasma physics. In such cases, the student’s supervision is also shared by an internal advisor from the department. College policy with departmental support allows students to pursue joint PhD degrees.

Applicants for admission to graduate work in physics or astronomy should present the equivalent of PHY 217, 218, 227, 235, 238, 243, 247, and MTH 164 and 281–282. Students who do not possess the proper qualifications for admission may be admitted under special circumstances, but will be required to correct all deficiencies during the first year of graduate study. Admission for study in astronomy and astrophysics does not presuppose any special background in astronomy. The number of graduate students admitted each year is limited. The department offers a variety of support to its students including fellowships and traineeships.

Candidates for the PhD degree are expected to complete eight advanced (400-level or higher) four-credit courses, at least two of which are specialty courses. These courses are usually taken during the first two years of study. A typical program for the PhD degree during the first year would include courses in mathematical methods (401, 403), at least one course in quantum mechanics (407), and one each in electrodynamics (415) and statistical mechanics (418), and during the second year would include one or two courses in mathematical methods (405, 406), one or two courses in advanced quantum mechanics (509, 510, 511), one or two other advanced courses (411, 413, 516, 519), and two specialty courses (chosen, for example, from 454, 455, 521, 522, 531, 532, 541, 542, 581, 582, and AST 403, 461, 462). Several other advanced astrophysics courses are offered on a less frequent basis. All graduate students are required to take the noncredit Graduate Research Seminar (PHY 597) during their first year.

A formal assessment of the preliminary core coursework (403, 407, 415, and 418) is intended to assure that each student has a comprehensive grasp of physics at the level of the core curriculum. Following the successful completion of the qualifying examination, which involves an oral presentation to a faculty committee, each candidate for the degree must complete a significant piece of original research, which is then formally presented in the dissertation and which must be defended in the final oral PhD examination. Students are encouraged to begin research activity in their first year of study. All PhD candidates become involved in some teaching activity at some point of their studies. This usually means conducting recitation or laboratory sessions in introductory undergraduate courses. One year of teaching is required of each full-time student and a second year is highly recommended. Research and teaching activity is required of all students working toward the PhD degree whether or not they are awarded any form of financial support.

Seminars and colloquia on various topics of research both by visiting and resident physicists and astronomers are scheduled regularly, and constitute an important component of graduate education.

### PHYSICS

**401. Mathematical Methods of Optics & Physics**

*Prerequisites: MTH 164, MTH 282, or equivalent*

Study of mathematical techniques such as contour integration, transform theory, Fourier transforms, asymptotic expansions, and Green’s functions, as applied to differential, difference, and integral equations. (Prior Titles: Complex Analysis and Diff Equations & Mathematical Methods of Theoretical Optics). (Cross-listed with OPT 411). (Fall)

**402. Probability**

*Prerequisite: None.*


**403. Data Science I: Modern Statistics & Exploration of Large Data Sets**

Review the fundamentals of probability and statistics and learn to apply them in commonly encountered practical data analysis problems, including parameter estimation, hypothesis testing, regression, simulation, and advanced error analysis (both statistical and systematic). This course will have theoretical and practical components. Once the theoretical concepts are covered, the emphasis will be to apply them to actual calculations with data. Students will learn to use a software package employed in the manipulation and analysis of large data sets, and they will write their own computer programs to carry out calculations using supplied data sets.
404. Linear Spaces  
Prerequisite: MTH 235 or equivalent  

405. Geometrical Methods of Physics  
Prerequisite: MTH 235 & 236 or equivalent  

406. Symmetries in Physics  
Prerequisites: PHY 401, PHY 404, or equivalent  
Finite groups. Compact and non-compact Lie groups and Lie algebras. Group representation theory. (Spring)

407. Quantum Mechanics I  
Prerequisite: PHY 246 or permission of instructor  

408. Quantum Mechanics II  
Prerequisite: PHY 407 or equivalent  
Symmetries including parity, lattice translations, and time reversal. Stationary-state and time-dependent perturbation theory, Stark and Zeeman effects, fine structure, transition probabilities. Scattering theory with applications. Elementary QED, multipole and plane-wave expansions, properties of the photon. The Dirac equation and elementary mass renormalization. (Spring)

411. Mechanics & Chaotic Dynamics  
Prerequisite: PHY 235  
Lagrangian and Hamiltonian dynamics, canonical transformations, Hamilton-Jacobi equations, chaotic dynamics, periodic orbits, Stable and unstable orbits, Julia and Fatou sets, Convergence of Newton’s Iteration, KAM theory. (Offered the first 8 weeks as 311A). (Fall)

Prerequisites: ME 402, or PHY 401, or OPT 411, or consent of the instructor. Some FORTRAN experience desirable.  
Computational solutions to coupled nonlinear partial differential equations arising in engineering and physics. Emphasis on current problems and techniques. (Spring)

413. Gravitation  
Prerequisite: AST 231  
Motivation for a metric theory of gravity, principle of equivalence, principle of general covariance, mathematical tools, curvature tensor, Einstein field equations and solutions, energy momentum tensor, weak field approximation. Applications and optional topics include experimental tests; black holes; relativistic star models; cosmological models; early stages of evolution of the universe; gravitational waves. (Fall)

415. Electromagnetic Theory I  
Prerequisite: PHY 401 or concurrently  
An advanced treatment of electromagnetic phenomena. Electromagnetic wave propagation, radiation, and waveguides and resonant cavities, diffraction, electrodynamic potentials, multipole expansions, and covariant electrodynamics. (Fall)

418. Statistical Mechanics  
Prerequisites: PHY 227 or equivalent; PHY 407, PHY 408 concurrently  
Review of thermodynamics; general principles of statistical mechanics; micro-canonical, canonical, and grand canonical ensembles; ideal quantum gases; applications to magnetic phenomena, heat capacities, black-body radiation; introduction to phase transitions. (Cross-listed with MSC418). (Spring)

420. Introduction to Condensed Matter Physics  
An emphasis on the wide variety of phenomena that form the basis for modern solid state devices. Topics include crystals; lattice vibrations; quantum mechanics of electrons in solids; energy band structure; semiconductors; superconductors; dielectrics; and magnets.

422. Med Imaging-Theory & Implemt  
426. Physics of Radiotherapy II  
428. Physics of Radiotherapy II  
429. Organic Electronics  

431. Nano-Optics  
Prerequisites: Advanced calculus and vector analysis, electromagnetic theory (OPT 462 or equiv.) and quantum mechanics (OPT412 or equiv.)  
Nano-optics is an emerging new field of study motivated by the rapid advance of nanoscience and technology. Traditionally, the diffraction limit prevents us from optically interacting with matter on a nanometer scale. However, in recent years several new approaches have been put forth to ‘shrink’ the diffraction limit or to even overcome it. The interaction of light with nanoscale...
matter renders unique information about structural and dynamical properties. Therefore, optical techniques are of great importance for the study of biological and solid-state nanostructures. The course in nano-optics addresses the key issues of optics on the nanometer scale. Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: Theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy near-field optical microscopy, and resolution criteria. (Fall)

432. Quantum Information Lab

434. Quantum & Nano Opt Lab
Prerequisite: PHY 123 or PHY 143

This advanced optics teaching laboratory course will expose students to cutting-edge photon counting instrumentation and methods with applications ranging from quantum information to biotechnology and medicine. It will be based on quantum information, the new, exciting application of photon counting instrumentation. As much as wireless communication has impacted daily life already, the abstract theory of quantum mechanics promises solutions to a series of problems with similar impact on the twenty-first century. Major topics will be entanglement and Bell’s inequalities, single-photon interference, single-emitter confocal fluorescence microscopy, Hanbury Brown and Twiss correlations/photon antibunching. Photonic based quantum computing and quantum cryptography will be outlined in the course manuals as possible applications of these concepts and tools. The full course will consist of four laboratory experiments and a special final meeting of students oral presentations. (Fall)

435. Principles of Lasers

This course provides an up-to-date knowledge of modern laser systems. Topics include quantum mechanical treatments to two-level atomic systems, optical gain, homogeneous and inhomogeneous broadening, laser resonators and their modes, Gaussian beams, cavity design, pumping schemes, rate equations, Q switching, mode-locking, various gas, liquid, and solid-state lasers.

436. Spectroscopy and Kinetics

This course covers the basic theory and experimental practice of spectroscopy in molecules and condensed matter. A general review of electromagnetic waves is followed by classical and quantum mechanical descriptions of the interaction between light and matter. These basic principles are then applied to vibrational and electronic spectroscopy. This course will also cover the principles of kinetic analysis in the context of time-resolved spectroscopies used to quantify the dynamics of photoexcited species. We will refer to examples from the literature to illustrate the experimental implementation and interpretation of advanced spectroscopic techniques.

437. Non-Linear Optics
Prerequisite: Open to any graduate student or undergraduates who have taken OPT 261, 262, 224, and 225.

Fundamentals and applications of optical systems based on the nonlinear interaction of light with matter. Topics to be treated include mechanisms of optical nonlinearity, second-harmonic and sum and difference-frequency generation, photonics and optical logic, optical self-action effects including self-focusing and optical soliton formation, optical phase conjugation, stimulated Brillouin and stimulated Raman scattering, and selection criteria of nonlinear optical materials. (Cross-listed OPT 467).

438. Optical Communications Systems

The course is designed to give the student a basic understanding of the optical communications systems while making one aware of the recent technological advances. The following topics are covered: components of an optical communication system, propagation characteristics of optical fibers, light wave sources such as light-emitting diodes and semiconductor lasers, optical receivers, noise analysis and bit error rate, coherent, multichannel, and solution-based communication systems. Cross-listed OPT 428 (Fall)

439. Nonlinear Optical Spectroscopy

This course will cover a broad range of optical spectroscopic techniques and will focus on theoretical methods for their microscopic interpretation. A general correlation function methodology for analyzing nonlinear optic experiments in terms of molecular dynamics and relaxation processes will be developed. The relationships among ultrafast (time-domain) and frequency-domain techniques will be discussed. Applications will be made to fluorescence and Raman spectroscopy, three and four wave mixing, photon echo, hole burning and transient gratings in the gas phase and condensed phases. Optical materials and nanostructures will be discussed. (Cross-listed OPT 459, CHM 459). (Spring)

440. Nuclear and Particle Physics
Prerequisites: PHY 123, PHY 237 (or instructor permission)

This course is designed for physics majors interested in the development of nuclear and particle physics. The course describes the properties of nuclei and various models useful for the description of nuclear properties. The models and ideas include the liquid drop model, shell model, collective model, radioactivity, fission, and fusion. Properties of particle interactions with matter are covered, and used to develop principles of detections used in nuclear and particle experiments. The physical ideas behind various existing accelerators are discussed. Finally, the fundamental interactions of elementary particles and their constituents are reviewed, with emphasis on issues pertaining to the conservation of quantum numbers and symmetries observed in the high-energy collisions. (Cross-listed with PHY 254). (Fall)
445. Advanced Nuclear Science Education Laboratory
**Prerequisites:** PHY 123/143; not open to freshmen and sophomores.

The students enrolled in ANSEL will develop a sophisticated understanding of our terrestrial radiation environment and of some of the important applications of nuclear science and technology. They will acquire practical skills in the routine use of radiation detectors, monitors, and electronics, and develop the ability to assess radiation threats and prospects of their abatement. The four in-depth ANSEL experiments are designed to help recreate a type of well-rounded, competent experimental nuclear scientist who is able to analyze an experimental problem, to select, design, and set up appropriate nuclear instrumentation, and to conduct required measurements. The laboratory sessions will meet twice a week for 2 hours and 40 minutes. The students are expected to write detailed lab reports on their work, and give a presentation on of their experiments at the end of the semester. In addition to the laboratory component of ANSEL students will attend a weekly lecture (1 hour and 15 minutes per week). (Spring)

446. Nuclear Science & Technology I
(Formerly CHM 446) - Nuclear technologies of measurement, accelerators and radiation detection, effects and applications of radiation. Fundamental particles interactions, quark model. Nuclear masses, sizes, and shapes. Overview of microscopic and macroscopic models of the nucleus. Nuclear radioactivity and decay modes. Introduction to nuclear reaction theory, classical potential scattering, semi-classical and quantal models of scattering, nuclear excitation, and mass transfer. Mathcad computer projects. Two 75 minute lectures per week, homework problems, and computer simulations.

451. Physics of Astrophysics I
One half of the required 2 part sequence (can be taken before or after AST 452). Focuses on the physics of radiation production by ionized and atomic matter, the transfer of radiation through matter, and what we measure from astrophysical objects. Concepts are developed from first principles and many applications in astrophysics are studied.

452. Physics of Astrophysics II
**Prerequisite:** PHY 451
Continuation of PHY 451. (Cross-listed with AST 462). (Spring)

453. Spec Top: high Energy Den Phy

454. Introduction to Plasma Physics
**Same as ME 434**
**Prerequisites:** PHY 217, PHY 218, or equivalent
Orbit theory, adiabatic invariants, collective effects, two-fluid and MHD equations, waves in plasma, transport across magnetic fields and in velocity space. (Course was listed as PHY 426). (Fall)

455. Introduction to Plasma Physics II
Vlasov equation, Landau damping, VanKampen modes, two-stream instability, micro-instabilities, introduction to kinetic theory, shield clouds, Thomson scattering, and the Fokker-Planck equation.

456. Compressible Flow
**Prerequisites:** ME 225, ME 201, or MTH 281
Acoustics; linearized equations for homogeneous media; mathematical theory of linear waves; waves in stratified atmospheres; geometrical acoustics. Finite amplitude compressible flow; one-dimensional waves and the theory of characteristics; shock waves; steady two-dimensional flow. Radiative transfer; emission and absorption in gases; equation of radiative transfer; radiative effects on waves. (Cross-listed with ME 436). (Fall Spring)

457. Incompressible Flow
The study of incompressible flow covers fluid motions which are gentle enough that the density of the fluid changes little or none. Topics: Conservation equations. Bernoulli’s equation, the Navier-Stokes equations. Inviscid flows; vorticity; potential flows; stream functions; complex potentials. Viscosity and Reynolds number; some exact solutions with viscosity; boundary layers; low Reynolds number flows. Waves.

458. Geometric Methods in Fluids
This course will focus on applying methods of Riemannian geometry to fluid mechanics. At an elementary level, it involves using curvilinear co-ordinates to solve Euler and Navier-Stokes equations in various geometries; e.g., rotating and self-gravitating fluids. At a deeper level, the Euler equations are the geodesic equations in the infinite dimensional group of volume preserving diffeomorphisms. We can understand the instabilities of a fluid in terms of the sectional curvature of this space (the work of Arnold). Flow along the principal directions of this metric relates this back to “force-free” flows in fluid mechanics. Self-gravitating fluids of interest in astrophysics, relativistic fluids of nuclear physics, fluids near a critical point and quantum fluids such as Bose condensates will also be studied this way.

459. Turbulence

462. Medical Imaging Theory & Implementation
**Prerequisite:** ECE 242. See ECE 452/OPT 452/BME 452.
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Special attention is given to the Fourier transform relations, reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI.

464. Biological Physics
**Prerequisites:** PHY 227, Z37 or instructor’s permission
Physical aspects of special topics in biology. The purpose of this course is to survey several important areas of biological and
medical physics. Topics covered include properties of biological membranes, transport and signaling in cells and tissue, photosynthesis, magnetic resonance imaging, and physical methods in biology such as nuclear magnetic resonance, x-ray diffraction, and optical absorption and fluorescence spectroscopies. The material is presented at the level of Russeu K. Hobbie’s, Intermediate Physics for Medicine and Biology. (Cross listed with PHY 253).

465. Phy of Radiotherapy I (No Longer Offered)

466. Physics of Radiotherapy II (No Longer Offered)
   Prerequisite: Permission of instructor only
   Continuation PHY 465. (Cross-listed with PHY 326). (Fall)

467. Ultrasound Imaging
   Prerequisites: BME 451/251, PHY 252 or BME 230/ECE 241 or equiv.
   Introduction to the principles and implementation of diagnostic ultrasound imaging. Topics include linear wave propagation and reflection, fields from pistons and arrays, beamfoaming, B-mode image formation, Doppler, and elastography. Project and final report. (Crosslisting PHY 257, BME 253/453, ECE 251/451). (Fall)

468. Physics of Radiotherapy II (Not Offered Any Longer)

475. Particle Physics
   The department hosts the PARTICLE (Physics and Rochester Teachers Inventing Classroom Experiments) program. Students (high school teachers) study the methods and techniques of experimental particle physics research by participating in the design and construction of detectors for classroom-based cosmic ray experiments. Prerequisite: permission of instructor.

493. Special Topics I
   Subject matter to be selected by instructor and students on an ad hoc basis in specific areas at the master’s level. (Fall)

494. Special Topics in Physics II
   Subject matter to be selected by instructor and students on an adhoc basis in specific areas at the master’s level. (Spring)

495. Master’s Research in Physics

497. Certificate in Coll Teaching

498. Supervised Teaching Assistant I
   Prerequisites: Students are required two weeks prior to the beginning of the Fall semester, to attend a two-day rigorous training program. Students prepare and present a short model recitation and are video taped for self-evaluation.
   This course is designed for a student to be Laboratory or Recitation Teaching Assistant (TA). Typically, the student spends the semester teaching two laboratories or up to four recitations during the Fall semester for the introductory physics courses: PHY 113, PHY 122, PHY 141, PHY 142, or introductory astronomy course: AST 111, or teaching one or more recitation(s): AST 111, PHY 113, PHY 122, PHY 141, PHY 142, or a 200 level undergraduate physics or astronomy course. Attendance of the weekly teaching seminars PHY 597-Fall, giving feedback to other leaders, and a constructive evaluation process are required. This course is non-credit and may be taken more than once. (Fall)

499. Supervised Teaching Asst II
   Continuation of PHY 498.

501. Adv Math Methods in Optics

509. Introduction Non-Relativistic Many Body Systems
   Prerequisites: PHY 407, PHY 408, or equivalent
   The basic concepts and techniques of many body systems and how they are used to extract their physical properties. Techniques to be covered are second quantization, Green’s functions, linear response theory, perturbative expansions based on Feynman diagrams, variational methods, and functional methods. Electron gas and other normal Fermi systems, Superconductivity, Interacting Bose systems and condensation, Quantum magnetic systems, Localization, etc. (Fall)

510. Advanced Quantum Mechanics
   Review of Dirac equation, covariance and transformation properties of the Dirac equation, propagator theory, applications, second order corrections and renormalization, Klein Gordon equation, non-electromagnetic interactions. (Spring)
511. Field Theory
Path integral formulation of quantum mechanics, free harmonic oscillator, fermionic oscillator, instantons, free scalar field, Green's functions, generating functional statistical mechanics as Euclidean field theory, partition function as a path integral, free Bose gas, interacting quanta, Green's functions and scattering amplitudes at tree level, symmetry, Ward identities, symmetry breaking and Goldstone theorem, effective action at one loop, 1d Ising model, 2d Ising model, duality, high and low temperature expansions, transfer matrix, scaling of coupling with lattice size. (Fall)

512. Renormalization
Prerequisite: PHY 509 or PHY 510
Review of basic concepts from PHY510, Non-Abelian gauge theories (QCD), Path integral quantization of gauge theories, BRST invariance, Ward identities, Ghost free gauges, Symmetry breaking and Higgs mechanism, Standard model, Regularization, Renormalization theory, Anomalous Ward identities, Schwinger model, Renormalization group equation and solutions, Callan-Symanzik equation. (Spring)

513. Magnetic Resonance Imaging: From Spins to Brains
Prerequisite: PHY 422/ECE 452
Magnetic Resonance Imaging: From Spins to Brains. See BCS 513.

516. E & M Theory II
Prerequisites: PHY 401 and PHY 415
A continuation of PHY 415 covering special relativity, radiation from moving charges, radiation damping, scattering and electrodynamics in material media. (Fall)

519. Statistical Mechanics II
Prerequisites: PHY 402, 408, 418
A continuation of PHY 418, involving the theory of imperfect gases, phase transition, and Brownian motion.

521. Condensed Matter I
(Also offered first 8 weeks as P321A)
Prerequisites: PHY 407, PHY 408, or permission of instructor
Classification of solids by crystal lattice, electronic band structure, phonons, and optical properties; X-ray diffraction, neutron scattering, and electron screening. (Fall)

522. Condensed Matter Physics II
(Also as MSC 551)
Prerequisite: PHY 521
Electron-phonon interaction, transport, magnetism, and topics of current interest such as superconductivity or localization, to be determined by the instructor. 

523. Solid State Quantum Optics
Subject matter to be selected by the instructor from among topics of current interest in solid state. (Cross-listing OPT 592). (Fall)

524. Spec Top in Solid State Phy
(Same as MSC 552 and CHE 552)
Prerequisites: PHY 521 and PHY 522 or permission of instructor
Subject matter to be selected by the instructor from among topics of current interest in solid state. (Fall)

525. Data Science II: Complexity and Network Theory
Prerequisites: MTH 165, PHY 402, PHY 404 or equivalent
As the number of interacting degrees of freedom (or agents) in a given system increases, its behavior often changes qualitatively, and not only quantitatively. Complexity is the emerging field of research, which investigates the shared underlying concepts and principles of such systems. It finds its applications in Physics, Computer Science, Mathematics, Biology, Social Sciences, Economy, and more. In this introductory course we will focus on these common features and their utilization in understanding complex systems. They will include for example: Fractals, non-linearity and chaos, adaptation and evolution, critical and tipping points, patterns formation, networks modeling, feedback loops, emergence and unpredictability, etc. Students in the course will be given ample opportunities to study farther these systems and/or techniques that are of particular interest to them. Prerequisites include basic knowledge in differential equations, linear algebra, and probability. (Fall)

526. Spin Based Electronics
Prerequisite: PHY 521 is strongly recommended or permission of instructor.
One example in the research of spin-based electronics (spintronics) which is motivated by the natural ordering of ferromagnetic phase can add to large scale electronics circuits. Generally speaking, we are left to manipulate the information whereas nature takes care of preserving it. The course is intended for students who are interested in research frontiers of future electronics technologies. The course begins with introduction to the basic physics of magnetism and of quantum mechanical spin. Then it covers aspects of spin transport with emphasis on spin-diffusion in semiconductor. (crosslisted with ECE 520/MSC 520). (Spring)

527. Introduction to Computational Neuroscience
Computational Neuroscience in Physics. See BCS 547.

531. Introduction to Quantum Optics
(Also as OPT 551)
Prerequisites: PHY 401, PHY 402, PHY 407, PHY 408, PHY 415 or permission of instructor
Classical and quantum mechanical theories of the interaction of light with atoms and molecules, with emphasis on near resonance effects, including coherent nonlinear atomic response
theory, relaxation and saturation, laser theory, optical pulse propagation, dressed atom-radiation states, and multi-photon processes. (Fall)

532. Quantum Optics of the Electromagnetic Field
Prerequisite: PHY 531 is recommended.
Properties of the free quantized electromagnetic field, quantum theory of coherence, squeezed states, theory of photoelectric detection, correlation measurements, atomic resonance fluorescence, cooperative effects, quantum effects in nonlinear optics. (Spring)

533. Quantum Optics of the Atom-Field Interaction
(Same as OPT 553)
Prerequisites: PHY 531, PHY 532
Subject matter to be selected from topics of current interest in quantum optics. (Fall)

534. Mechanical Effects in the Atom-Field Interaction
(Same as OPT 554)
Subject matter to be selected from topics of current interest in quantum optics.

535. Modern Coherence Theory
(Same as OPT 592)
Prerequisites: PHY 531, PHY 532
Theory of random process, stationarity ergodicity, the auto-correlation function and the cross-correlation function of random process. Spectrum of a stationary random process and the Wiener-Khintchine theorem, Second-order coherence theory in the space-time domain, the mutual coherence function, the degree of coherence. Second-order coherence theory in the space-frequency domain, the cross spectral density, mode representation, propagation problems. Inverse radiation problems, effects of source correlations and scattering of partially coherent light from deterministic and from random media. (Spring)

536. Speciﬁc Topics in Quantum Opt
(Same as OPT 556)
Prerequisites: PHY 531, PHY 532 or permission of instructor.
The instructor will choose a topic of current interest in Quantum Optics. (Spring)

537. Statistical Optics
Prerequisites: OPT 461 and OPT 462; students are encouraged to take PHY 404 concurrently.
Elements of applied probability theory - probability theory, random variables, density and distribution functions, moments of a random variable, characteristic and moment generating functions, and the central-limit theorem. Intro to stochastic processes stationarity and ergodicity, correlation functions, power of Wiener spectrum, Gaussian processes, Poisson point processes, compound Poisson point processes. Coherence properties of optical fields; temporal coherence, spatial coherence, propagation of the mutual coherence function, Van Cittert-Zernike theorem, effects of partial coherence on imaging systems. Laser Speckle and its applications: speckle statistics, addition of speckle patterns, integrated speckle, speckle statistics in the far field and in the image plane, space-time correlation functions, speckle velocimetry, and speckle interferometry. Photoelectric detection of light - semiclassical model for photoelectric detection, effects of stochastic fluctuations, low light levels, pattern recognition. (Spring)

538. Adv Top:light Wave Technology
Prerequisites: OPT 461, OPT 428 recommended, but not required.
This course is design to provide the student understanding of the recent advances in the field of lightwave technology. The following topics will be covered: Dispersive and nonlinear effects in optical fibers; linear and nonlinear properties of fiber Bragg gratings, linear and nonlinear properties of fiber couplers, fiber interferometers: including Fabry-Perot resonators, nonlinear fiber-loop mirrors, Mach-Zehnder interferometers, different kinds of fiber amplifiers and lasers, pulse-compression techniques, design of modern fiber-optic communication systems, optical solitons and their applications. (Cross-listed with OPT528).

539. Waveguide Optoelectronic Devices
This course examines in detail principles of operation of modern optoelectronic devices with an emphasis on waveguide devices. Topics generally include dielectric optical waveguides, coupled-mode theory, passive components, electro-optic devices, semiconductor lasers, semiconductor optoelectronic devices, and fiber lasers and amplifiers. (Cross-listed with OPT568).

541. Nuclear Structure I
Prerequisite: PHY 408 or permission of instructor.
Nuclear models and symmetries in nuclei; shell model, models pertinent in regions of strong pairing interactions, including BCS and generalized seniority; the microscopic theory of vibrations; rotational structures in heavy and light nuclei. (Fall)

542. Nuclear Structure II
Prerequisite: PHY 541
Electromagnetic and weak transitions; sum rules, introduction to nuclear reactions, theory of nuclear forces. (Spring)

544. Speciﬁc Topics:nuclear Physics
Prerequisites: PHY 541, 542
Subject matter to be selected from among advanced topics in the theory of nuclear structure and nuclear reactions. (Fall)
546. Nuclear Science & Technology II  
Prerequisite: PHY446/CHM466
Experimental and theoretical studies of heavy-ion scattering and reaction mechanisms; semi-classical and quantal scattering theory; Coulomb excitation; few-nucleon transfer; damped heavy-ion reactions; fusion and fission processes; statistical approaches to complex nuclear reaction mechanisms. Cross-listed with CHM 566. (Fall)

552. Magnetohydrodynamics
Basic equations of magnetohydrodynamics (MHD). The induction equation and kinematic MHD. Magnetohydrostatic equilibria and stability. MHD waves. Behavior of magnetic flux tubes. Viscous MHD flows. Dynamo theory. Selected applications, such as electromagnetic pumps and flowmeters, sunspots, the and the solar dynamo.

553. Laser-Plasma Interactions

554. Cosmology  
(Same as AST 554)  
Prerequisite: None.
Introduction to cosmology, covering the following broad topics: Introduction to the universe, introduction to general relativity, cosmological models and Friedmann-Walker universe, thermodynamics of early universe, particle physics of the early universe, and the formation of large-scale structure. (Fall)

555. Advance Topics in Plasma Phy  
(Same as ME 545)
Courses vary year to year. Topics include controlled fusion reactor concepts, including laser fusion, energy in the future, space plasmas, and astrophysical plasma phenomena. (Spring)

556. Hydrodynamic Stability & Turbulence

557. Plasma Stability  
(Same as ME 534)  
Prerequisite: ME 434 or permission of the instructor.
Stability of magnetically confined plasmas, delta-W formalism, double adiabatic equation, comparison theorem, shear stabilization, minimum-beta fields, resistive instabilities, Tokamak and Mirror stability theory. (Spring)

558. Intro-Inertial Confinement Fusion

564. High Energy Astrophysics
A survey of current research topics in high energy astrophysics. Topics drawn from X-ray and gamma-ray astrophysics, supernovae and planetary nebulae, binary accretors, astrophysics of compact objects (black holes, neutron stars, white dwarfs), plasma astrophysics, magnetic field-particle interactions, cosmic rays, astrophysical jets, active galactic nuclei. (Cross-listed with AST 564).

573. Physics and Finance
Introduction to econophysics and the application of statistical physics models to financial markets. Parallels between physical and financial phenomena will be emphasized. Topics will include random walks and Brownian motion, introduction to financial markets and efficient market theory, asset pricing and the Black-Scholes equation for pricing options. The course will also explore non-Gaussian Levy processes and the applicability of power law distributions and scaling to finance. Other possible topics include turbulence and critical phenomena in connection with market crashes. Cross listed as PHY373/573. (Spring)

581. Particle Physics I  
Prerequisites: PHY 408, PHY 509 (may be taken concurrently)
Particle interactions the their symmetries. The particle spectrum and its classification. Calculation of elementary processes. The quark model. CP violation. Accelerators and experimental techniques. (Cross-listed with 381A) (Spring)

582. Particle Physics II
Electroweak theory, and experimental evidence in support of it. Gauge theories and spontaneous symmetry breaking. QCD and color SU(3). Grand unification and recent advances. Particles and cosmology. (Fall)

584. Spec Topics in Particle Phy

591. PhD Readings in Physics
Special study or work, arranged individually.

593. Quantum Nanostructures

594. Internship
594A. Internship

595. PhD Research in Physics

595A. PhD Research in Absentia

595B. Phrsrch in Absentia Abroad

597. Teaching & Research Seminar

Prerequisite: None.

A (Fall) - Noncredit course given once per week, required of all first-year graduate students. The seminar consists of lectures and discussions on various aspects of being an effective teaching assistant, including interactions with undergraduate student body and cross-cultural issues. B (Spring) - Noncredit course given once per week required of all first-year graduate students. Members of the faculty discuss topics in their current area of research interest. (Fall Spring)

598. Teaching Workshop Leader Pedagogy Training

This course is designed for a student to be a Workshop Leader Teaching Assistant (TA). Typically, the TA attends the weekly Workshop Leader Training meeting that offers specialized support and training in group dynamics, learning theory, and science pedagogy for students facilitating collaborative learning groups for science and social science courses. The TA teaches three to four workshops in one of the fall semester introductory physics courses: PHY 113, PHY 122, PHY 141 or PHY 142. Additional requirements are: Attendance of the weekly Graduate Teaching Seminars PHY 597-Fall, giving feedback to other leaders and a constructive evaluation process. This course is non-credit and may be taken more than once.

599. Pedagogy & Group Leadership

This course is designed as a follow-up course for an experienced Workshop Leader, titled a lead Workshop Leader Teaching Assistant (TA). Typically, the TA attends the weekly Workshop Leader Training meeting that offers specialized support and training to develop leadership skills, to foster ongoing communication among faculty members and study group leaders, and to provide an environment for review of study group related issues. Students spend the semester teaching three to four workshops during the Spring semester introductory physics courses.

985V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

997A. Doct Dissertatn in Absentia

997B. Doc Diss in Absentia Abroad

999. Doctoral Dissertation

999A. Doct Dissertatn in Absentia

999B. PhD in Absentia Abroad

ASTRONOMY

403. Experimental Techniques in Astronomy

Prerequisites: The equivalent of PHY 217, 218 MTh 281 & PHY 227.

This course is an introduction to the tools of modern observation astronomy. We discuss geometrical and physical optics applied to telescopes and astronomical cameras; the physics of light detection at radio, infrared, visible, X-ray, and y-ray wavelengths; and the instruments and techniques used for observations of faint celestial objects over the faul useful range of spectral and angular resolution. The intention is to provide to students the preparation necessary to design, build and optimize astronomical instruments. However, the material should be useful to anyone who will be using remote-sensing instruments, astronomical or otherwise, or is seeking to understand measurements made with these devices.

450. Stellar Atmospheres

Prerequisites: PHY 407, PHY 408 and PHY 418, in the past or concurrently


453. Introduction to Stellar Interiors & Atmospheres

Prerequisites: PHY 407, PHY 408, PHY 418, or concurrently

A first course on stellar interiors and atmospheres in which approximately 50 percent of a semester is devoted to each. Stellar Interiors topics cover hydrostatic equilibrium, the Virial theorem, energy generation and transport, overview of stellar evolution, PMS Evolution, main sequence evolution, late evolution, evolution in close binary systems, stellar modelling (in part), the approach to real models. Stellar Atmospheres topics cover basic Radiative Transphere, transport Equation, Eddington-Barbier approximation, line and continuum transfer in LTE, radiative
transfer in static Plane-Parallel stars, exponential integrals and the Schwarzschild-Milne equations, Lambda, Phi and Chi operators, various Eddington approximations, Atmospheres of Static Plane-Parallel Stars, pressure stratification, temperature stratification, radiative equilibrium, Gray-atmosphere approximation, spectra from static Plane-Parallel stars, line broadening mechanisms, spectral line formation. See A450 & A553 for full-fledged courses.

**455. Astronomical Interferometry**  
*Prerequisites: AST 403 and PHY 415*

This course is an introduction to the principal technique of modern radio astronomy, and an increasingly important tool for infrared and visible wavelengths: spatial interferometry. We discuss the elements of physical optics, coherence theory, and the physics of detectors and receivers that bear on astronomical interferometry. We follow this formal development with a detailed account of the practice of interferometry, calibration, and data reduction. The intention is to provide to students all they need to know to understand, plan, propose, and analyze observations with such instruments as the Very Large Array (VLA), the Very Long Baseline Array (VLBA), the Owens Valley Radio Observatory’s (OVRO) Millimeter Array, and the Berkeley-Illinois-Maryland Array (BIMA) at Hat Creek Radio Observatory.

**461. Astrophysics I**  
*Prerequisites: PHY 407, PHY 408, PHY 415, PHY 418, in the past or concurrently.*

One half of the required 2 part sequence (can be taken before or after AST 462). Focuses on the physics of radiation production by ionized and atomic matter, the transfer of radiation through matter, and what we measure from astrophysical objects. Concepts are developed from first principles and many applications in astrophysics are studied. (course is cross-listed with PHY 451). (Spring)

**462. Physics of Astrophysics II**  
*Prerequisite: None.*

One half of the required 2 part sequence (can be taken before or after AST 461). Focuses on hydrodynamic and plasma processes relevant to astrophysics. Fundamentals of fluid dynamics and magnetohydrodynamics, fluid, MHD, and thermal instabilities, turbulence, supersonic and subsonic flow. Accretion physics, shocks, dynamos, particle accelerations in plasmas, dynamics of magnetic fields. Concepts are developed from first principles and many applications in astrophysics are studied. (Cross-listed with PHY 8452). (Spring)

**465. Observational Galactic Structure**  
*Prerequisite: Permission of instructor*

Star, gas, and dust distribution in our galaxy. Structure studies and classification of other galaxies. Clusters of galaxies, red shifts, Seyfert galaxies, peculiar galaxies, quasars. (Spring)

**551. Diffuse Matter in Space**


**552. Galactic Dynamics**

Boltzmann equation and collision theory. Structure and evolution of clusters, numerical experiments, Galactic hydrodynamics, wave theory of spiral arms, models of galactic nucleus regions, superdense cluster theory.

**553. Stellar Interiors**  
*Prerequisites: AST 461, AST 462 or AST 453*


**554. Cosmology**  
*(Same as PHY 554)*  
*Prerequisite: None.*

Introduction to cosmology, covering the following broad topics: Introduction to the universe, introduction to general relativity, cosmological models and the Friedmann-Walker universe, thermodynamics of the early universe, particle physics of the early universe, and the formation of large-scale structure. (Fall)

**563. Seminar On Radio Astronomy & Infrared Astronomy**

A survey of current research reports in scientific journals on topics including research on pulsars, quasars, and radio and infrared observations of the interstellar medium. (Fall Spring)

**564. High-Energy Astrophysics**  
*Prerequisites: AST 461, AST 462*

A survey of current research in high energy astrophysics. Topics drawn from X-ray and gamma x-ray astrophysics, supernovae and planetary nebulae, binary accretors, astrophysics of compact objects (black holes, neutron stars, white dwarfs, plasma astrophysics, magnetic field-particle interactions, cosmic rays, astrophysical jets, active galactic nuclei. (Cross-list PHY 564).

*Prerequisites: PHY 235, PHY 227, AST 241 (AST 461 & 462 are helpful), or with instructor’s permission*

Survey of theory and multi-wavelength observations related to the formation of early evolution of stars and planets. Interstellar medium, interstellar dust, molecular clouds, protostars, T Tauri stars, circumstellar disks, pre-main sequence stellar evolution, extrasolar planets and substellar objects, constraints on the protosolar nebula from meteorites and the planets. (Spring)
570. Solar System Dynamics
Prerequisites: AST 461, 462, 465.

591. PhD Readings in Astrophysics
Prerequisite: Instructors permission
Special study or work, arranged individually. (Fall Spring)

593. Astro Theory Seminar
Prerequisite: Instructor’s permission
Current theoretical topics of interest are explored in considerable detail. Topics vary from year to year and reflect research interests of staff.

594. Astro Observational Seminar
Prerequisite: Instructor’s permission
Current topics of observational or experimental interest are explored in considerable detail. Topics vary from year to year and reflect research interests of staff.

595. PhD Research in Astrophysics
Prerequisite: Instructor’s permission
Special topics in Astronomy and Astrophysics.

595A. PhD Research in Absentia
Prerequisite: Instructor’s permission
Special topics in astronomy or astrophysics

890. Summer in Residence - MA

895. Cont of Masters Enrollment

899. Master’s Dissertation

985. Leave of Absence

990. Summer in Residence
Political Science

Professors Duggan, Fey, Gamm (Interim Chair), Helmke, Jackson, Johnson, G. Powell, L. Powell, Rothenberg, Seligman, Stone
Associate Professors Clarke, Goemans, Jordan, Kalandrakis, Meguid, Primo, Signorino
Assistant Professors Abramson, Frey, Kroeger, Lacina, Lee, Montero, Paine

The Department of Political Science offers a program of graduate study leading to the degree Doctor of Philosophy. The primary purpose of the PhD program is to train scholars who will contribute to the future development of the discipline of political science through careers in teaching, research, or the private sector. The program at Rochester involves a distinctive approach to studying politics that emphasizes the development of formal theory and the analysis of quantitative evidence.

The doctoral program requires at least four, and typically five or six, years of full-time study. All entering students are expected to have a basic command of spoken and written English, as well as the equivalent of one year of college-level calculus.

Students must complete at least 14 regular courses in the PhD program, usually by the end of their third year, as well as the math “prefresher.” For most PhD students the first year of study is spent completing courses in the required theoretical and methodological sequences (PSC 404, 405, 407, 408, 480, and one graduate-level political philosophy seminar, typically 581) and exploring some substantive fields. The second year is spent on additional coursework and research culminating with the presentation of a research paper in the beginning of year three. Three fields of concentration (American Politics, Comparative Politics, International Relations, Political Philosophy, Methods, and Formal Theory) normally are completed by February 1 of the third year. One of these three fields must be either Methods or Formal Theory. A Master of Arts degree is awarded after the student passes the PhD qualifying examination by the end of the third year of study. Writing the PhD thesis is the major task of the remainder of the program. In addition, all PhD students receive as teaching assistants during their third and fourth years.

Because course offerings and policies are always subject to change, we encourage you to refer to our department’s website for the most up-to-date and accurate information.

To learn about our graduate program, please visit www.rochester.edu/college/psc/graduate/degree.php.

For a listing of graduate courses, please visit www.rochester.edu/college/psc/courses/search.php.

404. Probability & Inference

This course in mathematical statistics provides graduate students in political science with a solid foundation in probability and statistical inference. The focus of the course is on the empirical modeling of non-experimental data. While substantive political science will never be far from our minds, our primary goal is to acquire the tools necessary for success in the rest of the econometrics sequence. As such, this course serves as a prerequisite for the advanced political science graduate courses in statistical methods (PSC 405, 505, and 506).

405. Linear Models

In this course, we will examine the linear regression model and its variants. The course has two goals: (1) to provide students with the statistical theory of the linear model, and (2) to provide students with skills for analyzing data. The linear model is a natural starting point for understanding regression models in general, inferences based on them, and problems with our inferences due to data issues or to model misspecification. The model’s relative tractability has made it an attractive tool for political scientists, resulting in volumes of research using the methods studied here. Familiarity with the linear model is now essentially required if one wants to be a consumer or producer of modern political science research.

407. Mathematical Modeling

Elementary game theory applications (Nash Equilibria, Prisoner’s Dilemma, Chicken), measures of voting power, social choice (Arrow’s Theorem).

408. Positive Poltcl Theory

479. War & the Nation State

This course examines the development of warfare and the growth of the state from the French Revolution to the end of the Second World War. We examine the phenomenon of war in its broader socio-economic context, focusing on nationalism, bureaucratization, industrialization and democratization. We will go into some detail on the two major conflicts of the twentieth century, the First and Second World Wars. Students are required to do all the reading. Every student will make a presentation in class on the readings for one class (25% of the grade), and there will be one comprehensive final (75%).

480. Scope of Political Science

Uses basic concepts in the philosophy of science to explore a range of specific examples of research in the discipline with the aim of discerning more clearly what it means to say that social and political inquiry is scientific.

487. Theories of Political Econmy

In recent decades a number of important intellectual intersections have emerged between political science and economics. The course will explore these intersections as they appear in the work of scholars such as Amartya Sen, Elinor Ostrom, Roberto Unger, Dani Rodrik. Our aim is to explore the analytical, explanatory and normative implications of this work in hopes of discerning lessons for thinking about enduring political issues and institutions such as a property, markets, and democracy. Some prior course work in economics or political science will be helpful but is not required.
491. Master’s Readings in Pol Sci
495. Master’s Research in Pol Sci
502. Political & Econ Networks
504. Causal Inference
505. Maximum Likelihood Estimation

The classical linear regression model is inappropriate for many of the most interesting problems in political science. This course builds upon the analytical foundations of PSC 404 and 405, taking the latter’s emphasis on the classical linear model as its point of departure. Here students will learn methods to analyze models and data for event counts, durations, censoring, truncation, selection, multinomial ordered/unordered categories, strategic choices, spatial voting models, and time series. A major goal of the course will be to teach students how to develop new models and techniques for analyzing issues they encounter in their own research.

506. Adv Topics in Methods
508. Est Games & Testing Form Mod

513. Interest Groups
This course principally introduces students to the political science and political economy literatures on interest groups, with a special focus on how these groups operate in the context of American politics (however, contrast with other advanced and the European Union are included). This will include developing an understanding of the makeup of the group system, the contribution decision, the internal politics of organizations, and the role that groups play with respect to formal political institutions.

518. Emergence of the Mod Congres
Through intensive reading and discussion, we will analyze the major institutional features of Congress, with an emphasis on historical development. We will examine the basic institutions of the House and Senate—committees, parties, leaders, and rules. In doing this, we will consider the rise of careerism, the seniority system, agenda-setting, electoral concerns, divided government, efforts at institutional reform, party polarization, gridlock, and the Senate filibuster.

523. American Field Seminar
This seminar will introduce you to classic as well as contemporary research in American politics. We will discuss the literature both in political institutions (e.g., Congress) and in political behavior (e.g., voting). By covering an array of topics in these areas, the course will provide a foundation for developing a comprehensive understanding of the field and the various directions in which it is now moving.

530. Urban Change & Urban Politics
535. Bureaucratic Politics
536. Corporate Political Strategy
545. Judicial Politics

550. Comp Politics Field Seminar
555. Democratic Pol Processes
558. Comp Parties & Elections
562. Empir Research Pract

This course presents basic issues in empirical research in the social sciences. Classes will alternate between discussion of readings on approaches to empirical research and applied weeks, where students will present successive iterations of their own research in-progress. The research design topics covered will be generating observable implications of theory; case selection; collection of large-n observational and archival data; narrative case study; experiments and natural experiments; elite interviews; and participant observation. The course is intended for students preparing for their second year paper, third year students writing a dissertation prospectus, or ABD students with an empirical project that is at a fairly early stage. First-year PhD students should consult with the instructor prior to enrolling in the course. Students who take both PSC 562 and 563 may use either, but not both, to satisfy the course requirements for the Comparative Politics field.

563. Causal Inf: Appl & Inter
565. Poli Econ of Development
568. International Organization
569. State Formation
571. Quant Approach-Intl Poltcs
572. Internatl Politics Field Sem
573. Territ & Group Conflict

575. Social Choice, Electoral Competition, and Legislative Bargaining

The course covers the primary results in preference aggregation and applies them to models of elections and policy-making. The focus of the course is especially on dynamic models of politics. We begin by studying Arrow’s theorem and majority voting, we review the workhorse models of elections in the political economy literature, and we use these models to study taxation and inequality, interest groups and lobbying, etc. In the second part of the course, we extend the analysis to repeated elections.
and electoral accountability. We cover the literature on political agency with moral hazard and adverse selection. The course will consist of a mix of lectures, discussion, and student presentation of assigned readings.

576. Graduate Research Seminar

577. Theories of Conflict

579. Politics of International Finance

This course surveys the politics of international movements of capital, focusing on money as a power resource, the evolution of international cooperation in monetary policy, international financial institutions, and the domestic politics of macroeconomic adjustment.

580. Models of Non-Democratic Politics

This course will study game theoretic models that address core themes in comparative politics, focusing on non-democratic settings. Substantive questions include: How do authoritarian rulers maintain power? Why do countries democratize? How do states monopolize violence and prevent civil wars? The goal of the course is to understand the mechanics of important models from the literature as well as the broader research agendas to which these models contribute. This goal will enable students to identify cutting edge research questions in these literatures. The only requirement is completion of the first-year formal theory sequence or an acceptable alternative. Grading will be based primarily on problem sets and a final paper.

581. Philos. Foundations of Psc

584. Game Theory

This course is the third semester of the formal theory sequence for graduate students. It focuses on teaching students more sophisticated tools for modeling more complex games. Specifically, the course concentrates on games of incomplete information such as signaling games and communication games and develops analytical tools such as Bayesian-Nash equilibrium, perfect Bayesian equilibrium, and equilibrium refinements. The course also covers repeated games, bargaining games and equilibrium existence in a rigorous fashion. The prerequisites for the course are PSC 407 and 408, or an equivalent background in complete information game theory. Grading is based on homework assignments and a midterm and final exam.

585. Dynamic Models: Structure, Computation and Estimation

Dynamic considerations are becoming increasingly important in the study of such political processes as legislative policy making, the impact of the political cycle on macroeconomic performance, the stability of international systems, the conduct of war, and regime change. The course develops the theory of dynamic models in decision and game theoretic environments, develops numerical methods for the computation of these models, and culminates with a thorough treatment of statistical estimation of dynamic models. The goal of the course is to equip graduate students with analytical, numerical, and statistical tools that can be used in their future research on applied topics, and specific applications will be considered at some length. Some familiarity with a programming language (such as Matlab or R) is a plus, but the dedicated student should be able to acquire basic programming skills needed for the course.

586. Political Economy II

This course covers much of the modern game-theoretic literature on models of voting and elections. It is meant to expose students to the techniques and models used in this line of research. Some of the topics covered include probabilistic voting, policy-motivated candidates, candidate entry, strategic voting, and issues of information in elections, including uncertainty on the part of voters and candidates, and problems associated with private information in elections. The course covers both complete and incomplete information models and thus students must have a working knowledge of Bayesian games prior to taking this course.

587. Structural Modeling an Estimation

588. Comp Politics & Elections

589. Political Economy I

The course covers the primary results in the literature on preference aggregation and applies them to models of elections and policy-making. The focus of the course is especially on dynamic models of politics, with an emphasis on structural similarities between models of bargaining and elections. We begin by studying Arrow’s theorem and majority voting, and we review the workhorse models of agenda setting and static elections in the political economy literature, including the setter model of Romer and Rosenthal and the Downsian and probabilistic models of elections. The analysis moves to the study of the Baron-Ferejohn model of bargaining and dynamic models of elections, including the two-period model of political agency with adverse selection and moral hazard. We end by considering the fully dynamic bargaining model, in which the status quo evolves endogenously over time, and the infinite-horizon political agency model.

591. PhD Readings in Pol Sci

594. Research Internship

595. PhD Research in Pol Sci

595A. PhD Research in Absentia

890. Summer in Residence - MA

895. Cont of Master’s Enrollment
897. Master’s Dissertation
899. Master’s Dissertation
985. Leave of Absence
986V. Full Time Visiting Student
990. Summer in Residence
995. Cont of Doctoral Enrollment
997. Doctoral Dissertation
997A. Doct Dissertatn in Absentia
997B. Doc Diss in-Absentia Abroad
999. Doctoral Dissertation
999A. Doct Dissertatn in Absentia
999B. PhD in-Absentia Abroad

Religion & Classics

RELIBION (REL)
403. Medieval Drama
491. Readings
591. PhD Readings in Religion
890. Summer in Residence - MA
986V. Full-Time Visiting Student
987V. Part Time Visiting Student
990. Summer in Residence

CLASSICAL GREEK (CGR)
491. Master’s Reading Course

CLASSICAL STUDIES (CLA)
450. Ethnic Identity Anc Grc/Rome
451. Ancient Greek Historiography
491. Master’s Reading Course

LATIN (LAT)
421. Medieval Latin Prose
Introduction to a variety of Medieval Latin texts. Students complete independent studies of an author or topic of their choice.

450. Latin Skills
This course focuses on the development of listening, speaking, and writing skills for Latin students and prospective teachers.

491. Master’s Reading Course
495. Master’s Research Latin
591. PhD Readings
890. Summer in Residence - MA
895. Cont of Master’s Enrollment
990. Summer in Residence
Center for Visual Science

Professors DeAngelis, Duffy, Feldon, Fienup, Foxe, Gan, Huxlin (Associate Director), Jacobs, Knox, Lennie, MacRae, Merigan, Paige, Pasternak, Phipps, Rolland, Rucci, Schieber, Williams (Director), Yoon
Associate Professors Briggs, Lalor, Libby, Mahon, Majewska, Romanski, Tadin, Zavislan
Assistant Professors Buckley, Haefner, Hunter, Kidd, Kuriyan, Maddox, Mitchell, Padmanabhan, Poletti, Raizada, Schallek, Singh

The Center for Visual Science provides specialized coursework and advanced research facilities for graduate students and postdoctoral students in various disciplines that involve the field of visual science. This is done with the cooperation of faculty who have their primary appointments elsewhere in the University. Prospective students with an interest in this area might be drawn from any one of the following departments: brain and cognitive sciences, biomedical engineering, neuroscience, neurology, optics, ophthalmology, and computer science. Courses in the Center for Visual Science are available to any graduate student working toward degrees in any of the regular departments of the University.

448. Vision and the Eye
This course will reveal the intricate optical and neural machinery inside the eye that allows us to see. It will describe the physical and biological processes that set the limits on our perception of patterns of light that vary in luminance and color across space and time. We will compare the human eye with the acute eyes of predatory birds and the compound eyes of insects. The course will also describe exciting new optical technologies for correcting vision and for imaging the inside of the eye with unprecedented resolution, and how these technologies can help us understand and even cure diseases of the eye. The class is intended to be accessible to advanced undergraduate students, especially those majoring in Optics, Biomedical Engineering, or Brain and Cognitive Science, but is recommended for anyone with a curiosity about vision or an interest in biomedical applications of optics. The course will also serve as an introduction to the study of vision for graduate students.

491. Master’s Readings

493. Master’s Special Topics

495. Master’s Research

504. Sensory Systems
An introduction to the functioning of the senses and the physiological mechanisms underlying them. Topics include vision, audition, somatosensation, the vestibular system, gustation and olfaction, with an emphasis on the general principles that govern mammalian sensory systems.

505. Perception & Motor Systems
An interdisciplinary introduction to perception and action. Topics covered include the perception of motion, depth, surfaces, pattern and object perception, eye movements, motor planning and organization, and attention.

524. Multisensory Processing
This is a reading seminar that will look at modern research on statistical learning in a number of areas in perception, action and cognition. The course will focus on studies of how the brain adapts to the statistics of both sensory inputs and motor outputs with the goal of finding common conceptual links between diverse behavioral domains, including, sensory adaptation, motor adaptation and learning, visual perception, language processing and various cognitive functions (e.g. causal learning).

528. Special Topics in Vision
Advanced seminar on a chosen problem in vision sciences. In previous years topics have included motion perception, stereopsis, color vision and visuo-motor control. Readings for the course are drawn from the scientific literature in the topic being covered. Students are typically required to lead discussions on papers. (Fall Spring)

591. PhD Readings

595. PhD Research

595A. PhD Research in Absentia

890. Summer in Residence - MA

990. Summer in Residence
Visual and Cultural Studies Program

Professors Berlo, Crimp, Duro, Foster, Michael, Willis
Associate Professors Haidu, Saab
Assistant Professor Middleton
Affiliated Faculty: Professors Bernardi, Gustafson, Schaefer; Associate Professors Hwang, Reichman, Scheie, Seiberling, Tucker, Wolcott; Assistant Professors Creech, Doran

An interdisciplinary program in Visual and Cultural Studies at the University of Rochester, this is one of the few programs in the country that offers graduate degrees with an emphasis on art, media, and film theory, criticism, and cultural studies.

The program offers students the chance to earn a doctoral degree by doing intensive work in several of Rochester’s humanities departments. Primary faculty for the Visual and Cultural Studies Program teach in the Departments of Art and Art History, Anthropology, English, Modern Languages and Cultures, and the Eastman School of Music. Students may also take courses from other departments, for example in history, or education, as part of their studies.

The program stresses close interpretation of art, film, and media within social and historical frameworks. Students are able to relate recent developments in literary and cultural theory to visual works and to investigate the interrelationships between critical texts and visual culture. The graduate program encourages students not only to gain detailed knowledge about their chosen field, but also to develop critical, analytical skills. Students explore culture in its social and historical context, and employ a variety of critical methods and perspectives.

Rochester’s Program in Visual and Cultural Studies is one of the few in the country that offers a doctorate in interdisciplinary critical theory and visual studies. It is also unique in its strong emphasis on the analysis of visual culture.

There are currently 30 graduate students in residence in the program.

AH 583. Colloquium in Visual and Cultural Studies

The Colloquium introduces students in the Visual and Cultural Studies Program to aspects of the histories, theories, and methodologies of our field of study. We proceed in three ways: First, we read and discuss together a series of texts on and in visual and cultural studies. Second, various faculty members in the program conduct sessions in their areas of expertise based on readings that they select for us. And third, each student presents his or her own work to the colloquium. For this final part, it is important that students engage with visual and cultural studies models and provide relevant readings to other members of the colloquium.

CORE AND ELECTIVE COURSES*

AH 402. Chinese Film

This course presents an overview of cinema in China, Taiwan, and Hong Kong from the 1930s to the present, considering how cinema has served a means of representing and reshaping Chinese historical identities and everyday life at home and abroad. The course approaches film as a mixed medium of narrative, image, and sound and focuses on how it represents the spectacle of modern China by mediating among recurring issues of modern (especially urban) life, the persistence of the past, the relations of place to Chinese and global culture, and the staging of these questions through issues of gender and ethnicity. Throughout, close attention is paid to the interaction of themes, narrative genres (such as melodrama), formal techniques, and cultural and social context.

AH 403. Digital Cityscapes

Most of our interactions today with the geography of a city are digital—phones are used to find a location, Facebook map is marked to show places that have been visited, GPS information is embedded into photos. Beyond these everyday uses, digital projects abound that map historical and statistical data onto geographical locations, drawing connections between physical locations and more abstract information. This course examines the ways these interactions between the digital and the physical shape our understanding of the world around us. Materials and discussions are in English.

AH 407. Film History: 1989–Present

This class explores global trends in film history from 1989 to the present. In considering the contemporary period of cinema, the course looks at the technical, social, and formal aspects of the medium. Of particular interest are new digital technologies for production, post-production, and exhibition in both commercial and independent filmmaking (e.g., CGI, HD, Motion Capture, High Frame Rate), all of which are linked to a network culture that emerges after 1989. The course also focuses on geopolitical developments and social upheavals such as the end of the Cold War, the events of September 11, 2001, economic and cultural globalization, and the post-2008 financial crisis as all of these altered various national/regional cinemas and genres (e.g., the spy film, the horror movie, the comedy-drama, and action movies). The course screens the works of major figures in late twentieth-century and early twenty-first century world cinema from the United States, China, and Hong Kong to Palestine, Iran, India, and Senegal.

AH 412. What Photo Is

What does color do to ideas of photography that were born in the black-and-white era? How does digital manipulation further alter our understanding of the medium? Does the invention of cinema change “what photo is”? Do social institutions—from

* Offerings vary from year to year. Arrangements may be made for directed courses in studio.
charity and social justice to profiling and social networking, all of which owe some of their cultural importance to photography—change what photography is? This course uses readings, lectures, discussions, visits to the Eastman House, and working with photographers to promote deeper understandings of what photography has been and can be to enable students to “read” photographs more complexly and historically.

AH 413. Race and Gender in Popular Film
This course explores Hollywood’s fascination with race and gender as social issues and as spectacles. In particular, the course focuses on the ways that social differences have become the focal point of conflicted narrative and visual interactions in films. To examine competing representations of racial difference and sexual difference in U.S. culture, the course analyzes popular films from the 1950s to the present.

AH 414. Beyond the Boundaries
Roadside signs, weathervanes, quilts, nutcrackers in the shape of a woman’s body—what do vernacular and popular objects from the nineteenth century to the present tell us about American culture? These problematized classes of objects are sometimes called craft, folk art, outsider art, or vernacular art. This course charts the history of thought about these rubrics, from late nineteenth-century European writings on craft and ornament to early twentieth-century American writings on folk art, to the contemporary fascination with “outsider” art. In some semesters, this course may focus on specialized topics, such as “folk erotica” or vernacular environments.

AH 415. Contemporary Art: Theory and Practice
Pop, Minimalism, Conceptualism, Video Art, Performance Art, Feminist Art. Not all of them began in the 1960s, but all of them converged to make it the most complex and fertile decade of the postwar era. The course focuses on these developments by examining key artists—Warhol, Beuys, Hesse, among many—and the major arguments that helped form both the art of the era and the way we think of it today.

AH 437. The Architecture of Frank Lloyd Wright
This course traces the career of Wright with detailed analysis of selected buildings, the development of Wright’s ideas about architecture, and his place in the development of modern architecture. All types of buildings are considered, including those in the domestic and public spheres as well as urban planning. Particular attention is placed on Wright’s considerable output in writing along with the critical appraisals of his contemporaries, as well as comparison of related architecture. This course requires three substantial essays on topics given out during the term.

AH 450. Age of Baroque
This course addresses the painting, sculpture, and architecture of seventeenth-century Europe. The art examined ranges from Italian ecclesiastical architecture through to the art of Louis XIV’s Versailles, Spanish court art, and the art of the Dutch Republic. Artists studied include Poussin, Rembrandt, Bernini, Borromini, Caravaggio, van Dyck, Velasquez, Rubens, and Vermeer. While there is no one methodology that adequately explains this varied and exuberant period, the course focuses on the development of a Baroque way of seeing—the better to understand the stylistic break between the Renaissance and the Baroque on the one hand and the Baroque’s relationship to the Rococo on the other. The course is structured around lectures, but every class includes time for a group discussion. Several classes are held at the Memorial Art Gallery, utilizing MAG’s rich holdings of Baroque paintings. Readings are available via the library’s web page and linked to weekly discussions.

AH 455. American Art
What did it mean to be American? What did America look like, geographically and in terms of its people? What part did art and photography play in documenting and giving an identity to Americans in the century between 1850 and 1950? Attention is given to documenting and representing the West, immigration, and the emerging urban environment. Students work with the collections of George Eastman House and the Memorial Art Gallery. Requirements for the course include a short museum paper, a term paper with draft, and take-home midterm and final exams.

AH 459. Women, Cloth, and Culture
Why is it that throughout history and across different cultures, women are often associated with “soft goods” (cloth) rather than “hard goods” (sculpture)? This course focuses on case studies that analyze women’s varied roles in the production and use of cloth, from indigenous societies of Africa and the Americas, to colonial encounters in those regions, to modern artistry and the structures of globalized industry. Topics may include raffia cloth made by royal women in Central Africa, textiles of Maya weavers of Guatemala, nineteenth-century American quilters, Massachusetts “mill girls” of the 1850s, feminist artists of the past fifty years, and women and textile factory work in Asia today.

AH 462. Impressionism and Post-Impressionism
This course deals with the interconnecting artistic concerns and subjects of artists such as Manet, Monet, Renoir, Pissarro, Morisot, Cassatt, Cezanne, Van Gogh, and Gauguin. It also investigates ways in which paintings and prints made during the later nineteenth-century in France in their representations of the city, the suburbs, leisure activities, and gender roles participated in communicating a particular world view. In addition to developing general skills of analysis, students emerge from the course with a strong feeling for the artists as individuals and artistic personalities, an ability to recognize and date their pictures, an ability to interpret subjects, and an understanding of the way in which institutions operated in a seminal period in modern art.

AH 466. African-American Visual Culture
This course surveys African-American visual culture (including painting, sculpture, photography, prints, textiles, mixed media, installations, performance, and video) in the United States from Colonial times to the present. Its purpose is to introduce students
to as wide a range of artistic productions and to provide a social historical frame for the interpretation and analysis of works of art. The course encourages students to question the theoretical, ideological, and aesthetic assumptions of artists, collectors, art critics, and art historians in making and categorizing artistic production. In particular, this course explores the ways in which the constructs of "race," "gender," and "diaspora" have influenced representational practices, the training and education of artists, public and private patronage, art criticism, and art historical analyses.

AH 474. Cultural History of American Architecture

This course explores critical issues in American architecture from an interdisciplinary perspective that focuses on the built environment. How do spaces shape history? Can we locate the history of slavery, corporate capitalism, the Cold War, or cultural imperialism within their respective architectural spaces: the plantation, the family home, the skyscraper, the fallout shelter, or the international hotel? Over the course of the semester this course looks at contemporary monographs of specific spaces alongside the work of key architectural historians and theorists. In addition, the course discusses novels, films, and paintings that foreground the centrality of architecture within American modernity.

AH 477. The Museum and “the Other”

For well over 100 years, Euro-Americans have tried to explain and interpret indigenous cultures by means of representations in museums. This course examines museum displays of Native American and African visual culture, as exemplified in a century of public exhibits. These range from Franz Boas’s displays in the American Museum of Natural History in New York City in the 1890s to exhibits in the planning stages at the time the course is being offered. Pivotal moments of inquiry include Indian Art of the United States, African Art in Motion, Into the Heart of Africa, Chiefly Feasts, and the professor’s own Plains Indian Drawings 1865–1935: Pages from a Visual History. The course also examines how Native American and African-American artists, scholars, and curators have represented their own cultures and critiqued Euro-American representations.

AH 481. Art and the City: New York in the ‘70s

The recession and fiscal crisis of the 1970s was paradoxically a highly productive period of artistic experimentation in New York City. In the wake of the transforming art movements of the 1960s—Pop, Minimalism, and Conceptual Art—the 1970s saw the invention of new and hybrid media: video art, performance art, and site-specific installation works. By the end of the decade, a new group of artists that came to be known as the Pictures Generation began showing in alternative spaces such as Artists Space. This seminar studies how the de-industrialization of New York City contributed to new kinds of art making and examines how artworks take the city as their subject. Among the artists considered are Bernd and Hilla Becher, Gordon Matta-Clark, Joan Jonas, Peter Hujar, Danny Lyon, Cindy Sherman, and Thomas Struth. Avant-garde film also took the city as its subject; the course includes the work of such film and video makers as Dara Birnbaum, Ernie Gehr, Peter Hutton, Babette Mangolte, and Charles Simonds.

AH 492. The Modern City

This course takes an interdisciplinary approach to examining the modern city in moments both of triumph and of crisis. The idea of the “city” has played a major role in conceptualizing modernity (as well as postmodernity). The course looks at representations of the metropolis in painting, photography, film, and philosophy. Using critical theory, urban planning documents, as well as fictional accounts, the course explores competing ideological perspectives on and debates over the place of the city in modern culture.

AH 506. The Sublime

The principal objective of the course is to undertake a re-evaluation of the received ideas associated with the operation of the sublime in eighteenth-century art, literature, and thought. Considered first is the concept in the writings of Edmund Burke and Immanuel Kant, the better to understand the parameters of a notion that not only shaped eighteenth-century aesthetic theory but also provided the conditions for the advent of Romanticism. Following this groundwork, the course focuses on a series of topics, including the paintings of Joseph Wright of Derby, Fuseli’s illustrations to John Milton, the art and poetry of William Blake, the writings of Ralph Waldo Emerson, and the American sublime. Themes in the course include the classical sublime, the scientific industrial sublime, the beautiful and the sublime, the picturesque, the natural sublime, the transcendental sublime, and the romantic sublime.

AH 507. Rhetoric of the Frame

The task of any discussion of frames and framing in the visual arts whether in painting, sculpture, film, performance, architecture, graphic novels and cartoon strips, or digital media is first and foremost to counter the tendency of framing devices to invisibility with respect to the artwork they supposedly contain. We see the work, but we do not see the frame. It is against this tendency to ignore the frame that this seminar is directed. At first glance the frame may seem to be as unproblematic. Starting from a consideration of the foundational texts of frame theory in the philosophy of Immanuel Kant, this course examines the discursive limits of the material and non-material border in the writings of, among others, Mayer Schapiro, Martin Heidegger, Jean-Claude Lebensztejn, Louis Marin, Craig Owens, and Jacques Derrida.

AH 508. Mimesis: Theory and Practice

This seminar course addresses the issue of imitation and Mimesis through the consideration of key texts from antiquity to the present. Texts include the foundational philosophies of Plato and Aristotle, the many theorists of literature and art of the sixteenth and seventeenth centuries who wrote on imitation, and the reaction against imitation in modern art. Both graduate and undergraduate students have the opportunity to select a topic related to their own interests and develop it into a research paper; in addition, graduate students present their paper in class.
AH 512. Postwar Art and Theory: The Sixties

Pop, Minimalism, Conceptualism, Video Art, Performance Art, Feminist Art. Not all of them began in the 1960s, but all of them converged to make it the most complex and fertile decade of the postwar era. The course focuses on these developments by examining key artists—Warhol, Beuys, Hesse, among many—and the major arguments that helped form both the art of the era and the way we think of it today.

AH 515. Feminism and Visual Culture

Feminism has had a powerful impact on the developing field of film theory from the 1970s to the present. This course examines the major feminist work on film, moving from the earlier text-based psychoanalytic theories of representation to theories of feminine spectatorship to studies of reception contexts and audiences. The course also gives attention to the very important role of feminist theory in television studies. Weekly screenings keyed to the readings test the value of these positions for close critical analysis of the film or television text. Readings include Laura Mulvey, Kaja Silverman, Constance Penley, Judith Mayne, Linda Williams, Jacqueline Bobo, Valerie Smith, Lynn Spigel, Lynne Joyrich, and Julie D’Acci.

AH 520. The Politics of Space

Prerequisite: permission of instructor.

This class explores how space is constructed and politicized. From the nineteenth-century flaneur to the twenty-first-century cyber communities, from the global economy to domestic interiors, space has been and continues to be ideologically contested terrain. Together, students and professor explore these contests. Close attention is paid to questions of identity formation, particularly as they relate to issues of gender, race, and class. In addition, the course investigates the importance of technology in transforming the ways in which we think about space.

AH 525. Contemporary Art and Culture

The recent explosion of political art that takes up specific problems or causes, treats past or current events, or merely postures politically suggests questions that criticism has been slow to address. Is it the artist or the artwork that articulates a political position? Is art responsible to political and social life? Do artists speak for all of us? And what types of art, which media—which formations (including realism, abstraction, montage, etc.) and which viewing positions—are appropriate? Or can appropriateness be determined? An intensive reading beginning with a set of readings about paranoid criticality; moving through several theoretical texts on art and visual culture; and returning to the problem of politics, war, and catastrophe in art through several contemporary examples. Requires no specific background but an investment in art and art history.

AH 554. The Films of Jean-Luc Godard

This course surveys the career of Jean-Luc Godard from Breathless (1959) to In Praise of Love (2001). Through close analysis of his films and range of critical responses the course explores numerous issues that Godard places before us as spectators and critics. While Godard is perhaps most famous, even notorious, for his commitment to politically engaged cinema, his interests in history and aesthetics remain central across this diverse corpus. Although he is known for his experiments in style and medium, he also remains committed to traditional film history and art history. The course explores the complex relationships his films establish between image and word, between sound and image, between stillness and motion. Analyses examine the central importance of literature and art history, as well as of popular culture, to the individual films and the corpus as a whole.

AH 556. Theorizing Documentary

This graduate seminar provides an introduction to the vibrant field of contemporary documentary studies that finds its home in the annual international Visible Evidence conference. It examines theoretical approaches to documentary film and video and reality television since the publication of Bill Nichols’s landmark study Representing Reality. The seminar explores perspectives on reality-based film and media rooted in cultural studies, feminism, Marxist theory, queer theory, critical race studies, and phenomenology. The course includes texts by Bill Nichols, Jane M. Gaines, Vivian Sobchack, Brian Winston, Michael Renov, Alexandra Juhasz, Cynthia Fuchs, Abé Mark Nornes, and others.

AH 584. The Visual Culture of Heritage and Identity

This course is a continuation of AH 593 and is limited to first-year students. Students should enter with a fully articulated project. The first few classes are dedicated to research and writing strategies. The rest of the semester is dedicated to the students’ projects. At the end of the semester, students present their work in a professional, conference-style format and complete a paper worthy of publication in an academic journal.

ANT 426. Culture and Consumption

This course explores anthropological approaches to the study of mass consumption and material culture. Specific topics for investigation include possessions and personhood; the history of modern consumerism in the West; and the globalization of markets. The course addresses these and other topics through case studies of common food items such as sugar, cheese, and bread. Students are required to develop and present a brief research project; students registered for ANT 226 will be asked to do projects on food-related issues. Projects may make use of ethnographic and/or historical methods and/or primary research materials.

ANT 466. Global Culture

This course introduces students to various ways in which cultural anthropologists do research and fieldwork. Cultural anthropologists study the human situation in all its manifestations; their work enables us to expose the limitations of self-evident truths and to reveal the possibilities of alternative views. Students are asked to think both critically and comparatively about institutions such as kinship, politics, and religion. The course also
addresses questions of cultural diversity and social inequality, including questions of race, class, and gender in contemporary America. It challenges students to consider the fate and value of cultural differences in a world connected and shaped by global flows of people, money, media, and technologies.

**ANT 506. Advanced Topic Seminar—The Corporation**

Prerequisite: declared anthropology majors and minors who have taken ANT 101 and one 200-level core course; graduate students by permission.

The modern for-profit, investor-owned business corporation is one of the most consequential inventions of the last 150 years. This seminar takes stock of the surprisingly sparse anthropological work on the corporation and considers the prospects for an anthropology of corporations that does not devolve into a broad discussion of global capitalism or a narrow account of organizational behavior. The seminar thus focuses on the specific historical, legal, and structural features of the corporation. Topics for discussion include the corporate form; corporate personhood; corporate branding; shareholder activism and corporate social responsibility; transnational corporations and “the bottom of the pyramid.” Students are asked to propose, develop, and present a semester-long research project that focuses on one particular corporation.

**ANT 457. Chinese Society after Mao**

This course adopts an anthropological approach towards understanding the dramatic sociocultural transformations that have followed in the wake of China’s post-Mao economic reforms. What happens when a society officially committed to economic and gender equality witnesses the rise of stark social divisions? Beginning with a historical overview of the key features of the Maoist and post-Mao periods, the course moves on to examine such issues as the creation of a market economy, the rise of new social classes, rural to urban migration, changing ideologies of gender and sexuality, new attitudes towards education and work, transformations in family life, religious revival and conversion, and the influences of global popular culture and mass consumption, with an eye towards identifying both continuities and departures from the Maoist era. Throughout discussions, students consider the implications of these changes for China’s political, social, and economic futures.

**CLT 409. On Genealogy**

As we come to know them, abstract concepts such as love and justice tend to have the appearance of being natural and unchanging: simply the way things are. According to a particular strain of modernist thought beginning with Friedrich Nietzsche and developed most systematically by Michel Foucault, this seeming naturalness is, in fact, a complicated and consequential cultural product. This advanced course scrutinizes this intellectual tradition and seeks to apply its insights to religion, politics, literature, and the arts.

**CLT 411B. French Film: The New Wave**

This course provides a detailed examination of the French filmmakers of the New Wave, from 1959 to 1967. The course examines the work of Jean-Pierre Melville, Claude Chabrol, Francois Truffaut, Jean-Luc Godard, Eric Rohmer, Agnes Varda, and Jacques Rivette. It also explores the films’ historical context and influence through some attention to their predecessors and successors. Knowledge of French helpful but not necessary.

**CLT 414A. Tourist Japan**

Japan’s image as a foreign destination, focusing on 1900–70: Japan defining itself and being defined by others through visual and material culture; the value of material culture in historical practice and theory.

**CLT 416A. Mexican Film**

Visitors to Mexico already have Hollywood versions of the country in their heads, but the “real” Mexico is a much more complex place. Archetypes of tough hombres, renegade outlaws, dark and sultry women, or beach bums lolling under the hot sun fall by the wayside when Mexican cinema introduces the grittier and much more varied realities of the contemporary nation. This course explores both historical antecedents and contemporary visions. It includes films by directors such as Spanish exile Luis Bunuel, Alejandro Gonzalez Inarritu, Jaime Humberto Hermosillo, Alfonso Cuaron, Carlos Reygadas, Raul Ruiz, Maria Novaro, and other box office favorites. From Robert Rodriguez’s *Bedhead* to *Desperado*, *Once Upon a Time in Mexico*, and, of course, *Y tu mama tambien*, *Entre Pancho Villa y una mujer desnuda*, and *La ley de Herodes* we explore images of Mexican culture. Course taught in English, but work may be written in Spanish for Spanish credit.

**CLT 419. Contemporary Popular Film: Race and Gender**

Weimar Germany (1918–33) was a tumultuous era. This short period, with a world war on either side, was one of great economic instability and political unrest culminating in the failure of Germany’s first attempt at democracy. At the same time, it was a particularly rich moment for artistic creativity, and Germany was the center of many innovations in the arts, literature, film, and architecture. Looking at various movements such as Expressionism, Dadaism, and New Objectivity, this course explores the more varied realities of the contemporary nation. This course considers the implications of these changes for China’s political, social, and economic futures.

**CLT 430. Film as Object**

Film studies involves the critical analysis of the pictorial and narrative qualities of motion pictures, film theory, and film history, understanding film as both industry and creative art. This course unconventionally focuses on the tangible object at the origin of the onscreen image and what we can learn about the social, cultural, and historical value of motion pictures and national film cinemas through an understanding of “Film” as an organic element with a finite life cycle. Focus is on the photographic element but includes a consideration of alternative “capture media.”
**CLT 434. Queer Theory**

This course examines literary, artistic, and theoretical representations of gender and sexuality as they have changed in the course of the twentieth century. The focus is on texts from Western Europe and the United States, but we will also consider other perspectives. From the New Women to French Feminists and transnational feminism, from homophobic societies to “queer nation and gay marriage, from Sigmund Freud to Michel Foucault and Judith Butler, this course explores the contested and politically charged debates around gender and sexuality that have shaped our views of identity over the last century.

**CLT 447. The Holocaust: Aesthetics of Representation and Negotiation**

How does one represent the unrepresentable? This is the key question explored in the films and literature about the Holocaust. Looking at fictional films, novels, documentaries, and memoirs, the course reflects on topics including memory, trauma, truth, and representation. This course offers a look at the ways in which artists and their audiences negotiate the themes of loss, horror, and redemption within the context of the Holocaust and its aftermath.

**CLT 451. Strangers in a Strange Land**

Jews have lived in Germany since the Middle Ages and have contributed a great deal to German culture, as well as developing unique German Jewish cultures; these facts are often overshadowed by the tragic events of World War II. This seminar explores the rich and diverse German Jewish cultures of the nineteenth and twentieth centuries in a range of texts, including fiction, film, travel texts, and philosophical and historical writings. Topics include the Haskalah (Jewish Enlightenment), assimilation, Zionism, anti-Semitism, and the relationship between eastern and western European Jews. Readings and discussions in English.

**CLT 457. Kristeva**

This course explores the beginnings of the horror and detective genres in the nineteenth century. Particular attention is devoted to the narrative structure, tropes, and psychological content of the strange tales by Poe and Hoffmann. Theories of horror are also addressed to include discussions by Lessing, Todorov, Huet, and Kristeva.

**CLT 481. Popular Film: Sex and Violence**

This course explores Hollywood’s fascination with race and gender as social issues and as spectacles. In particular, the course focuses on the ways that social differences have become the focal point of conflicted narrative and visual interactions in our films. To examine competing representations of racial difference and sexual difference in U.S. culture, we analyze popular films from the 1950s to the present.

**CLT 481A. Contemporary French Thought**

Through close analysis of popular film, this course explores contemporary French culture as it reworks national identity. Focusing on changing definitions of “Frenchness,” the course examines its articulations with shifting conceptions of tradition, of the popular, and of the nation. Readings include central cultural conflicts around identity and difference in the context of the emergent European economic community, as well as the specifically French context of “immigration” and “assimilation.” Of particular interest is the comparative analysis of French and U.S. popular discourses on social issues involving sexuality and gender, race, ethnicity, and “multiculturalism.” Films include works by Bertrand Blier, Luc Bresson, Andre Techine, Cyril Collard (Savage Nights), Mathieu Kassovitz, Claire Denis, François, Ahmed Bouchala (Krim), and Karim Dridi (Bye-Bye) as well as recent works by such widely known auteurs as Claude Chabrol and Jean-Luc Godard.

**CLT 482. Marx and Marxism**

It is not overstated to say that the works of Karl Marx have provided the transformational impulse to many of the changes of the twentieth century. Who was this person, Karl Marx? Why is it that in this post–Cold War world his writings continue both to inspire and threaten contemporary readers? How have those inspired by Marx further developed his ideas to constitute the discourse of Marxism? This course begins with discussions of key works by Marx and then moves on to examine some significant contributions to Marxism. Additionally, majors and minors can sign up for GER 211, where significant texts are read and discussed in German.

**CLT 482A. Nietzsche and the Nietzscheans**

Friedrich Nietzsche continues to be one of the most influential modern philosophers, yet controversy surrounds almost every aspect of his life and work. This course helps students go beyond the controversy in order to consider Nietzsche’s texts discerningly and how he approached the problems of truth, power, and morality. Close examination of his most important writings are complemented by inquiry into Nietzsche’s effects on twentieth-century philosophy. Other thinkers include Martin Heidegger, Michel Foucault, Sarah Kofman, Jacques Derrida, and Giles Deleuze.

**ENG 431. Twentieth-Century British Novel**

When the now-classic novels of writers like Conrad, Woolf, Joyce, and Lawrence were published in the first part of the twentieth century, readers were shocked by both their style and content. In the face of revolutionary upheavals in social and political life and in the understanding of human psychology and personal relationships, these writers proclaimed the end of fiction as we know it. This course examines what made this work appear so shocking. Looking at the way modernist fiction explores the limits and possibilities of language and representation, this course considers how this literature changed in the second half of the century with the construction of postmodern and postcolonial identities. A recurring focus is on the relationship between landscape and inner consciousness, cultural and psychic displacement, and the changing understanding of what constitutes “Britishness” in this turbulent century. Applicable English clusters: Novels; Modern and Contemporary Literature.
ENG 434. Modern Fiction

Fiction is a genre defined by its falseness. It is made up of invented material and stands in opposition to fact. In this study of modern British and American fiction (1890–1950), the course examines the ways that some of the most influential writers of the past century have foregrounded the action of imaginative invention. As the course sets out in search of the paradoxical truths expressed by the masquerade of fiction, it’ll be looking at strategies of deception, exaggeration, and contradiction. Writers the course considers include Henry James, Joseph Conrad, Gertrude Stein, Samuel Beckett, James Joyce, Virginia Woolf, Ernest Hemingway, and William Faulkner.

ENG 437. Marxism and Feminism

The course deals with some twentieth-century American and European (especially eastern European) poets in a manner that foregrounds the transfer of particular styles beyond the languages in which the poems were originally written. The course pairs some names together and through that discusses how post-1945 poetry translations inspired or influenced the ways of writing and the ways of thinking about poetry, both in the United States and in Europe. Through close reading of the poems written in English and translated into English, the course also explores how some of the local cultural contexts become part of the contemporary international tradition. The poems discussed include works by C. P. Cavafy, Derek Mahon, Zbigniew Herbert, Aleksander Wat, W. H. Auden, Miron Białoszewski, Wislawa Szymborska, Mirosław Holub, Charles Reznikoff, John Cage, Bertolt Brecht, D. J. Enright, Frank O’Hara, Kenneth Koch, and John Ashbery.

ENG 450. Race in American Fiction

This course provides a basic introduction to some of the major works and themes in American literature, focusing primarily on the development of the novel and short story, with limited attention to poetry and drama. It begins in the nineteenth century and works its way through such contemporary writers as Toni Morrison and Tony Kushner. The focus is on the creation of a national identity and how issues of race, gender, class, and sexuality intersect in the formation of an American literary tradition. Students trace a number of important themes such as the relationship between politics and art, the impact of slavery and the Civil War, immigration, the American dream, and the development of a national mythology and ideology. In the study of various movements in the American literary tradition, the course pays close attention to the intellectual debates concerning audience, language, and the purpose of art that have shaped key texts and historical time periods.

ENG 457. Media Studies

This course explores developments in world cinema—industrial, technological, social, and political—from 1959 to the present. It considers aesthetic and technical issues, including questions like the following: What brought about the collapse of the Hollywood studio system? What’s new about the French New Wave? What do we mean by “Third Cinema”? How do different national cinemas influence each other? Weekly screenings and film journals are required.

ENG 458. Feminism, Criticism, and Culture

Film studies involves the critical analysis of the pictorial and narrative qualities of motion pictures, film theory, and film history, understanding film as both industry and creative art. This course unconventionally focuses on the tangible object at the origin of the onscreen image and what we can learn about the social, cultural, and historical value of motion pictures and national film cinemas through an understanding of “Film” as an organic element with a finite life cycle. Focus is on the photographic element but includes a consideration of alternative “capture media.”

ENG 483. Media ABC: The Digital Age

Media ABC is an introduction to the very idea of medium and media—as in “the medium of print.” The goal is to come to a basic understanding of that concept. The perspective of the course is historical and critical. The key assumption is that media—the human voice, manuscripts, printed books, telegrams, photos, film, TV, paintings, electronic files—shape their “content”—words, pictures, sounds—and also shape their authors and their audiences. There have always been media because life cannot be lived without them. We are now experiencing a digital revolution. This remarkable media shift puts us among the first explorers to arrive on the scene of epoch-making changes. We should take advantage of our own unique intellectual opportunity to look back on the history of media from the powerful new perspective of digital media—and also to contemplate the great void that no medium has yet filled, the spaces of communication that we cannot yet cross.

ENG 551. Critical Theory—Foucault

Early in the twentieth century, criticism followed the success of science, trying to bring “method” to the subject. Written texts were treated as sacred texts and had been treated for centuries as having a higher, “holier” status than other, “vernacular” language genres. Criticism followed the standard set by both scientific and religious ideology. In so doing, it followed the androcentric tradition of the academy. In the 1930s and 1940s, Ludwig Wittgenstein and Mikhail Bakhtin presented a point of view that held no language genres to be elevated from others. They viewed symbolic genres as “texts” to be understood in relation to their roles in society and not as “holy writ.” These works as well as successors such as J. L. Austin, Jacques Derrida, Julia Kristeva, Tzvetan Todorov, feminist critics, and genre critics, added up to a movement of desacralization. Canons were deauthorized. Authors’ authority was diminished. Popular culture became important. Criticism and theory tried to open the study of language and literature.
ENG 552. Post-Colonial Theory

Media theory arguably began with Critical Theory, especially the debates between Theodor Adorno and Walter Benjamin in the early part of the twentieth century. This course explores how these two theoretical traditions intertwine in works that address the modernity thesis and mass culture; race, postcolonialism, and humanity; affect, neoliberalism, and labor; debt, bodies, and film; moving-image temporalities; publics and counterpublics; sensory experience; and visual culture. Readings are drawn from Adorno, Benjamin, Fredric Jameson, Stuart Hall, Marshall McLuhan, Hannah Arendt, Paul Gilroy, Lisa Nakamura, Brian Massumi, Ruth Leys, Lauren Berlant, Kathi Weeks, Sianne Ngai, Annie McClanahan, Mary Ann Doane, Miriam Hansen, Michael Warner, Whitney Davis, and others. Specific objects—films, photographs, television series, paintings, performances, books, websites, visualizations—will ground the class so that students can gain a deeper sense of how to do theoretical work that yields supplie accounts of media aesthetics.

ENG 553. Feminist Theory

Feminism has had a powerful impact on the developing field of film theory from the 1970s to the present. This course examines the major feminist work on film, moving from the earlier text-based psychoanalytic theories of representation to theories of feminine spectatorship to studies of reception contexts and audience. It also give attention to the very important role of feminist theory in television studies. Weekly screenings, keyed to the readings, allow students to test the value of these positions for close critical analysis of the film or television text. Readings include Laura Mulvey, Kaja Silverman, Constance Penley, Judith Mayne, Linda Williams, Jacqueline Bobo, Valerie Smith, Lynn Spigel, Lynne Joyrich, and Julie D’Acci

ENG 555. (Post) Cinematic Affect and Emotion

Film theory since Eisenstein has sought in various ways to understand the medium’s distinctive emotional and bodily effects upon spectators. The “affective turn” of the 1990s in critical theory more broadly opened up new avenues for film scholars to rethink spectatorship beyond psychoanalytic and semiotic paradigms prevalent in the 1970s and ’80s. This seminar considers the theoretical precursors to this affective turn but focuses in particular on scholarship from the 1990s to the present that analyzes the production and expression of affects and emotions in and between bodies onscreen and off. Students read texts that shaped contemporary affect theory (Silvan Tomkins, Eve Sedgwick and Adam Frank, Brian Massumi, Deleuze and Guattari), theories of affect and embodiment in film and media (Steven Shaviro, Elena del Rio, Laura Marks, Vivian Sobchack), cognitivist approaches to cinematic emotion (Carl Plantinga, David Bordwell), and cultural theory, including work by Lauren Berlant, Sianne Ngai, and Sara Ahmed.

ENG 557. Utopia and Literature

“Utopia” commonly refers to an ideal society; this course presents “utopia” as a para-literary genre, an occasion of societal modeling, and as a cognitive mode, attitude, and process. The course addresses literary representations of utopias throughout the tradition of literature in English. Topics for discussion include the relationship between utopia and dystopia (including “critical” utopias and dystopias), utopian literature’s influence on and representation in modern science fiction, the politics of utopias, and intersections with the history of intentional communities. Course requirements include a seminar paper, an in-class presentation on a critical reading, and class participation.

FR 462. French Philosophy since 1960

The French philosophers who erupted on the scene in the decades after 1960—namely Foucault, Derrida, Lyotard, Levinas, and, most recently, Jacques Rancière and Alain Badiou—have had an enormous and controversial impact not only on philosophy but also on the social sciences, literary studies, area studies, art history, theology, and film and media studies. This course studies the principal contributions of these figures, alongside critical interpretations of their work by late American philosopher Richard Rorty and the German philosopher Jürgen Habermas. Conducted in English.

HIS 440. Modernity through East Asia Eyes

What is modernity? What does it mean in China, Japan, and Korea? These are vital questions—but let’s not be scared away just because they seem abstract. This course seeks answers together through history, literature, and film. Each week, a theme (such as WAR, POWER, TIME, and RESISTANCE) is discussed through films and readings that helps students to see the puzzle one piece at a time. The goal is to uncover how modernity has been experienced and pictured on the other side of the globe. In the process, students gain not only a better understanding of East Asia, but also of themselves. Note: this seminar assumes at least some basic knowledge of Asian history or society. Contact the instructor if you have not taken at least one course on Asia.

HIS 482. Topics in Twentieth-Century American Cultural History

This seminar examines the history of beliefs about the end of the world in the western Judeo-Christian tradition. The seminar examines such topics as the birth of apocalyptic thought, the medieval development of various aspects of traditions about the End (such as the figure of Antichrist and millenarian traditions), millennial influences on the discovery and colonization of the New World, millennial movements of the last two centuries (such as the Millerites and the Mormons), and contemporary apocalyptic scenarios. A major theme of the course is the flexibility of apocalyptic language, its ability to interpret various historical situations, and its power to move people to acceptance or action.
**HIS 422. Topics in European Cultural History: From Mother Goose to Harry Potter—The Cultural History of Childhood in Modern Europe**

This course introduces students to the methods of cultural history through a survey of the history of European childhood since the eighteenth century. Topics covered include the material culture of childhood, including toys and children's books, the moral debate over child labor in the industrial revolution, the Victorian ideal of the innocent child, and the politics of childhood and education under nationalism, fascism, and communism. Course readings incorporate writing for, about, and (occasionally) by children, including childhood memoirs, theoretical works about childhood psychology and education, works of children's literature, and historical research on the history of childhood.

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**Interdisciplinary Master’s Programs**

Arts & Sciences, in recognizing the diverse interests of students, has developed and formalized interdisciplinary master’s programs. A standing committee of faculty acts as a “department” and supervises the program requirements for its students.

**Data Science**

Professors Dye, Ebinger, *Gildea, *Kautz (Director), *Luo, *Poduri, Zand
Associate Professor *Almudevar
Deputy Director Anand

The Goergen Institute for Data Science offers a program of study leading to a Master of Science degree. The 30-credit interdisciplinary degree program is completed in two to three semesters of full-time study. Students have the option to select a concentration in computational and statistical methods, health and biomedical science, or business and social science by completing 8 credits of elective courses in one area in addition to the required core courses. The program is designed for students with a background in any field of science, engineering, mathematics, or business. Prospective students should have programming experience and prior calculus coursework. For students with less extensive programming backgrounds, a summer bridging course is available. All students participate in an industry practicum course, serving as their Plan B (non-thesis) exit exam.

The components of the program are as follows:

- An optional summer bridging course for students who come without a strong computer science background.
- Four required core courses (DSC 462, DSC 465, DSC 440, DSC 461) for a total of 16 credits. Students may place out of one or more of the required core courses but will still be required to complete the 30 credits required for the program.
- A required 4-credit practicum in which the student works in a team to implement a significant system or analysis with a final oral presentation provided by each student. A committee of two faculty members from within the institute will evaluate the final oral presentation in order for it to serve as the master’s degree exit exam.
- Three electives selected from the area courses or research, for a total of 10 credits or more. Some of the area courses have prerequisites that students must satisfy. Eight credits

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1 Center for Integrated Research Computing
2 Department of Biostatistics and Computational Biology
3 Department of Brain and Cognitive Sciences
4 Department of Computer Science
5 Department of Electrical and Computer Engineering
6 Department of Physics and Astronomy
or more in one area would constitute a concentration, but a concentration is not required.

- A total of 30 credits are required to complete the program (without the bridging course) and many students will finish the program with more than 30 credits, depending on the elective area courses they select.

401. Tools for Data Science
This course provides a hands-on introduction to widely-used tools for data science. Topics include Linux; languages and packages for statistical analysis and visualization; cluster and parallel computing using Hadoop and Spark; libraries for machine learning; no-sql data stores; and cloud services.

450. Data Science Practicum
Prerequisites: This course is only open to data science MS students. CSC 440 and CSC 461 OR permission of instructor.

Students are expected to work on a large scale data analysis and mining project. An existing large database is used. Project categories include medical data analysis & social media data analysis. Data mining algorithms are applied to data that is contained in these databases to predict health hazards or social behavior. (Spring)

462. Computational Introduction to Statistics
This course will cover foundational concepts in probability and statistical inference, with an emphasis on topics of interest to computer scientists. Following an introduction to elementary probability theory, topics will include applications of combinatorics; Markov chains; principles of statistical classification (Bayes’ rule, sensitivity and specificity, ROC curves) and random number generation. The theory of statistical estimation and hypothesis testing will be introduced, and applied to one and two sample inference for population means, proportions, variances and correlations. Nonparametric procedures will be discussed. Topics also include statistical modeling (ANOVA, simple and multiple regression), and computational methods. Students will be introduced to the R statistical computing environment. (Fall)

465. Intermediate Statistical & Computational Methods
Prerequisite: DSC 462
This course is a continuation of CSC 462, covering intermediate statistical methodology and related computational methods, with an emphasis on the R statistical computing environment. (Spring)

475. Time Series Analysis

491. Master’s Reading Course

530. Methods in Data-Enabled Research Into Human Behavior and Its Cognitive and Neural Mechanisms
Prerequisite: none

This course provides a hands-on introduction to experimental and analytical methods in cognitive science and artificial intelligence. Each year, it offers three modules from a rotating list, including topics such as brain imaging, computational linguistics, and computer vision. The course is open to graduate students in any discipline. The course is recommended for who intend to pursue research in the intersection of cognitive science and computer science, but prior experience in those fields is not required. It is required for students supported by the BCS/CS NRT graduate training grant. For 2015, the modules are imaging and interpreting brain activity, large scale text corpus analysis, and sensing in the wild. (Fall)

531. Practicum in Data-Enabled Research Into Human Behavior and Its Cognitive & Neural Mechanisms
Prerequisite: DSC 530

In this interdisciplinary project course, graduate students will work in mixed teams to develop an artifact that addresses a research question and/or infrastructure need in the intersection of cognitive science and artificial intelligence. Students will learn principles of design by participating in the stages of brainstorming, specification, initial design, prototyping, refinement, and evaluation. The artifacts created by this course could include online showcases, demonstrations, tutorials, blogs, scientific papers, and software components to support further research. The course is required for students supported by the BCS/CS NRT graduate training grant, and should be taken the semester after the corresponding methods course. (Spring)

895. Cont of Master’s Enrollment

897. Masters Dissertation

985. Leave of Absence

Literary Translation Studies

Professors 1Grotz, 2Gustafson, 1London, 1Michael, 1Schaefer, 2Scott, Willis
Associate Professor 2Prendergast

Literary translation, an interdisciplinary master’s program at the University of Rochester, provides a multifaceted approach to the art, technique, and business of translation by combining academic rigor, strong practical training, and intensive professional development through internships with Open Letter, the University’s renowned imprint for literature in translation. The Literary Translation Program includes a Master of Arts degree. The Master of Arts in literary translation is for those preparing for careers as literary translators.

1 Department of English
2 Department of Modern Languages and Cultures
Requirements for the Master of Arts

The Literary Translation Program is composed of three components: a core, electives, and an annotated translation that serves as the Master’s Essay (for a Plan B program) or a thesis (for a Plan A program).

The core introduces students to the theories and problems of literary translation; furnishes them with an environment in which to work on a series of short- to medium-length translations independently and in consultation with their advisor; and provides a writing workshop in which they can hone their writing skills as translators of literature.

For their elective requirements, students may pursue at an advanced level their study of specific national literatures and of international literature as a global phenomenon. They may also elect to work as interns at a literary press.

The annotated translation is a book-length literary translation into English, accompanied by commentary addressing the particular challenges the students encountered with the work and a description of their resolution. It is expected that the translation be of near publishable quality. The very best translations are considered for publication by the Open Letter press.

Admission

- Bachelor’s degree or higher in related field
- Advanced knowledge of at least one language and literary tradition other than English
- An online application
- Official transcripts
- Three letters of recommendation
- Personal statement describing career and educational goals and prior experience with literary studies, translation, and languages other than English
- Translation sample (approximately 20 pages of fiction or drama, 200 lines of poetry) and copies of corresponding pages from source text

Courses

The Literary Translation Program is composed of three components:

I. Core Components—12 credits
II. Elective Components—12 credits
III. Translation Project Component—6 credits

All component courses are subject to school approval.

400M. Studies in Translation

This course will introduce students to the theoretical backgrounds, practical challenges, and creative activity of literary translation. We will survey appropriate theories of language and communication including semiotics, post-structuralism, pragmatics, discourse analysis, and cognitive linguistics. We will consider varied and conflicting descriptions by translators of what it is they believe they are doing and what they hope to accomplish by doing it; and we will study specific translations into English from a variety of sources in order to investigate the strategies and choices translators make and the implication of those choices for our developing sense of what kinds of texts translations actually are. Finally, students will, in consultation with the instructor or with another qualified faculty member, undertake exercises in translation of their own. By the end of this class each student should have a working knowledge of both the critical backgrounds and the artistic potentials of translation.

401. Translation Portfolio

Under the direction of an advisor, students complete an independent translation project—a group of poems or stories, a novella, or an excerpt from a novel or play—that will be the centerpiece of the student’s translation portfolio. (Fall)

401A. Contemporary Poetry
401B. Nobel Prize Literature
401M. Translation Portfolio

402. Mixed Genre Translation

403. Contemporary Poetry

406. Translation & World Literature

The focus of World Literature in Translation is to examine what makes a translation “successful” as a translation. By reading a series of recently translated works (some contemporary, some retranslations of modern classics), and by talking with translators, we will have the opportunity to discuss both specific and general issues that come up while translating a given text. Young translators will be exposed to a lot of practical advice throughout this class, helping to refine their approach to their own translations, and will expand their understanding of various practices and possibilities for the art and craft of literary translation.

406M. Translation & World Literature

410. Intro to Literary Publishing

This course runs in combination with an internship at Open Letter Books and focuses on explaining the basics of the business of literary publishing: editing, marketing, promoting, fundraising, ebooks, the future of bookselling, etc. Literature in translation is emphasized in this class, and all the topics covered tie in with the various projects interns work on for Open Letter Books. (Fall)

410M. Publishing Literary Trans

411. Polish and American Poetry

431. French Lit in Translation
432. Jewish Writer & Rebel

In February 2011, the website Jewcy published a list of the 50 most essential works of Jewish fiction of the last 100 years. The featured books come from many different languages, cultures, and time periods and are written in a myriad of literary styles. Although few would argue with the names on the list (Kafka, Bellow, Singer), the diversity of the authors involved raises the question: what makes Jewish literature Jewish? This course will attempt to answer that question by looking at an international group of writers (some of whom identify as Jewish and some of whom do not) who often challenge their (religious and cultural) upbringing as well as the dominant politics of the countries in which they live. The authors we will read include: Franz Kafka, Jakov Lind, Bruno Schulz, Edmund Jabès, Georges Perec and Clarice Lispector.

433. The Rewritable Beowulf

438. International Fiction

462. Colonial Latin American Lit

465. Don Quixote

474. Caribbean Novel & Theory

491. Master’s Reading Course

494. Master’s Internship

495. Master’s Research

895. Cont of Master’s Enrollment

897. Masters Dissertation

899. Master’s Dissertation

985. Leave of Absence

Photographic Preservation and Collections Management Program

Professors 1Foster, 2Rubin, 5Saab
Associate Professors 3Bernardi, 4Haidu, 5Middleton, 6Seiberling
Assistant Professors 4Allen 2Arnone, 4Hostetler, 2Lewis, 4Knapper, 8Shannon

The 1839 invention and subsequent development of the photographic medium have had profound scientific, aesthetic, historical, and social effects on world history. As compelling combinations of creative thought and record-keeping, photographs are keepers of both memory and historical information. The Photographic Preservation and Collections Management (PPCM) program combines theoretical insight with practical training so that students develop a holistic understanding of photography, from its history and material processes, to its multiple applications and physical characteristics. Students learn how to make preservation housings, what kind of temperature and humidity controls are needed to preserve photographs, and when to consult a conservator. The combination of advanced coursework and hands-on experience provides students with specialized knowledge in managing collections of photographs.

Requirements for the Master of Arts

The master’s degree in Photographic Preservation and Collections Management has four principal components: a core of required courses; a set of three elective courses; Internship Rotations, which consist of practical tasks related to museum collection management; and a master’s essay synthesizing the work students have done throughout the program.

The core of required courses provides students with an understanding of the histories of photography; collection registration and stewardship; research and cataloging methods; preservation issues and methodologies; and historic through contemporary photographic materials, processes, and their deterioration mechanisms.

Students choose the three elective courses from a designated array of offerings from five academic departments at the University of Rochester. These courses provide students with a broad and deep understanding of the photograph in its historical, aesthetic, and social dimensions, furnishing students with strategies for understanding visual culture from a variety of perspectives.

In their Internship Rotations, students execute projects supervised by George Eastman Museum staff in the Department of Photography and other areas of the museum that serve the museum’s photography collection.

The master’s essay is the degree program’s capstone project, in which students synthesize the work they have done over the course of the PPCM program. Master’s essays may be based on collection objects and be practical in nature with a written

1 Department of Anthropology
2 Department of Art and Art History
3 Department of English
4 George Eastman Museum
5 Department of History
6 Department of Modern Languages and Cultures
summary explaining the problems the student addressed and the methods employed to solve them. Or, they may be analytic papers on a given object or collection of objects that discusses them in terms of the particular theoretical, historical, and physical dimensions peculiar to those objects. They may also be hybrid works, combining practical and analytical components.

Admission
- Bachelor’s degree or higher in a related field
- Demonstrated knowledge of photography, museum practice, art and/or visual culture
- Practical experience with photography, museums, and/or digital assets management desired but not essential
- An online application
- Official transcripts from all post-secondary institutions
- Three letters of recommendation
- A statement of purpose describing career and educational goals; interest in the program; and prior experience with visual studies, photographic studies, preservation, and/or museum studies
- A writing sample, preferably on material relevant to visual studies, photography, or museums
- Students whose first language is not English will be required to submit TOEFL scores.
- Application fee

Program Components
The Photographic Preservation and Collections Management program consists of the following four components:
1. Core courses—24 credits
2. Elective courses—12 credits
3. Internship Rotations
4. Master’s Essay

REQUIRED CORE COURSES

422. Photographic Processes
This course will introduce students to the principles of photographic preservation and familiarize them with major photographic processes developed between 1839 and the present. Emphasis will be placed on understanding the basic physical and chemical composition of photographic objects and how their unique characteristics affect their long term preservation. Students will learn the skills needed to properly identify photographic processes, distinguish their deterioration mechanisms, and implement long term preservation strategies. (Fall)

423. Collections Management and Care
This course provides an overview of collection registration and cataloguing. (Spring)

424. History of Photography II

425. Catalog & Research Methods
The cataloging portion of the class is designed to familiarize students with the basic principles behind descriptive and subject cataloging. The research methods component is dedicated to teaching the methodologies that will allow students to undertake scholarly projects focused on the history of photography. (Spring)

430. Hist of Photo: 1839-1915
This class traces the emergence of photographic consciousness in the 19th century as it develops within a number of specific arenas of culture & representation, from the medium’s conception in the early 19th century to its modernization in the early 20th century. (Fall)

460. Masters Seminar
491. Independent Study
492. Master’s Essay
493. Master’s Essay
495. Master’s Research
895. Cont of Master’s Enrollment
897. Master’s Dissertation
899. Master’s Dissertation
985. Leave of Absence

MASTER’S ESSAY
Offered in the fall semester of the second year, the Master’s Essay course prepares PPCM students for the proposal and development of their master’s essay topic. As such, the course is organized in two parts. The first part is dedicated to writing a two- to three-page master’s essay topic proposal, to be delivered as a formal 10-minute presentation to PPCM program affiliates. The second is designed to assist students in developing their central research question(s) for their master’s essay; compiling a bibliography of primary and secondary sources (visual and textual); and writing a 10- to 12-page review of the literature, or bibliographic essay, related to their master’s topics.

ELECTIVE COURSES
Electives taken at the University of Rochester provide a framework in which to understand the production and reception of photographs as objects in both a visual cultural and an art historical context. PPCM students must complete three elective courses as part of the PPCM program. Electives will vary by semester.
INTERNSHIP ROTATIONS

Internship rotations are meant to provide additional and essential practical training to students through a series of work opportunities that occur in various museum and University departments such as the Library, Registrar, Department of Photography, Object Preparation, Exhibitions and Programming, and the Conservation Lab. Students engage in everyday activities within the museum or University, providing support to departments while also enhancing existing skills and acquiring new skills needed to be a successful collections professional and also be competitive in today’s workplace. Students are treated like colleagues and are encouraged to engage in their work with professionalism and contribute their own expertise to the projects they participate in.

Sustainability

Professors Anthamatten, Chen, Dye, Frontier, Garzione, Jorne, Poreda, Rothenberg, van Wijngaarden, Wu, Yates
Associate Professors Elder, Kessler, Petrenko, Rand, Rich
Assistant Professors Abar, Jusko, Murray, Weber

There is a growing need for professionals who have the experience and interdisciplinary training to craft innovative, practical solutions to provide energy, water, waste, and other goods and services in a more environmentally friendly, sustainable, and public health-conscious manner.

The Center for Energy and Environment helps students prepare to meet these needs by offering an MS in Sustainability. Our program blends a dynamic, interdisciplinary approach with individual mentoring to help students shape their course of study and crystallize their career plans. Students will benefit from a personalized, small program and the interdisciplinary resources of the University of Rochester’s highly ranked programs in environmental science, engineering, public health, and political science.

Our one-year master’s program teaches students the skills to understand and evaluate the environmental and public health impact of energy and other industrial production processes and usage and to suggest sustainable solutions. We provide students with a firm foundation in

- energy systems and alternative energy
- environmental geochemistry
- environmental health
- environmental law and policy

This foundation is supplemented by a robust offering of elective courses from which students can select to meet their individual needs.

This MS provides students with an opportunity to prepare for exciting new opportunities in sustainability, such as in alternative energy and policy development, as well as positions with companies, universities, nonprofits, consulting firms, government agencies, and other private and public institutions engaged in sustainability efforts addressing energy, environmental, and public health problems.

Master of Science without Thesis (Plan B)

The program in sustainability is only offered as a plan B or “coursework” master’s degree. It includes a minimum of 32 credits of required coursework and requires an exit examination. In addition to the coursework requirements and final examination, all students complete a practicum course. The practicum provides students with the opportunity to build experience while integrating principles from prior interdisciplinary coursework through either an internship, research project, outreach project or other suitable practicum. Students have a great deal of independence in the design of the capstone practicum experience, although we provide individual support and advice to students to help them explore a range of possibilities. At the end of their internship, research project, or outreach project, students produce a final product, such as a memorandum, report, or a poster.
detailing the work and findings. The suitability of the practicum to fulfill requirements for the degree are evaluated on a case-by-case basis. The practicum must have a sustainability-related focus and should be approved by the program director or codirectors in advance.

Professor Terry Noto advises students on the development of their student portfolio and résumé and the design of their capstone projects, tailored to each students career interests.

Program Admission Requirements
To be eligible for this program, you must have either a bachelor’s degree or a more advanced degree at the time of enrollment. Particularly strong applicants would have a BS degree in a relevant science, engineering, or social science discipline. All applicants must complete an online application and submit the following:
(1) a personal statement, (2) official transcripts from all previous college and university programs, (3) three letters of recommendation from former instructors or employers, (4) official Graduate Record Examination (GRE) scores, and (5) a writing sample is optional but encouraged. In addition, an official TOEFL examination report is required from all applicants for whom English is not their primary language. The completed application will be reviewed by program faculty and by the Graduate Studies Office in Arts, Sciences & Engineering. Applicants who believe they are eligible for admission to the program but do not meet the usual program requirements can request a waiver. Program faculty discuss all waiver requests and waive requirements if there is a compelling reason for doing so, subject to the Dean of Graduate Studies’ approval. Students interested in a waiver should contact either the program director, Carmala Garzione, or the codirector, Edwin van Wijngaarden.

Coursework Requirements
Coursework includes five core courses and four elective courses, culminating in a core practicum course that provides students with an opportunity to gain valuable research, outreach, or work experience in or outside of the Rochester area.

CORE COURSES
Either CHE 488: Intro to Energy Systems or CHM 486: Energy: Science, Technology & Society
All four of the following:
- SUS 401: Environmental Health
- EES 416: Environmental Geochemistry
- SUS 426: Environmental Law and Policy
- SUS 499: Practicum (1–4 credits)

Susan B. Anthony Institute for Gender, Sexuality, and Women’s Studies

Associate Professor Nora Rubel (Director)
Tatyana Bakhmetyeva (Associate Academic Director)

The Susan B. Anthony Institute for Gender, Sexuality, and Women’s Studies offers an advanced Certificate in Gender, Sexuality, and Women’s Studies for students who are enrolled in a graduate degree program at the University of Rochester and for nonmatriculated students who complete four or more courses from at least two University of Rochester graduate programs (see www.rochester.edu/college/wcs).

Gender, Sexuality, and Women’s Studies focuses on the changing cultural, economic, political, and psychological relations among people of all genders and sexualities. Because the discipline asks questions about gender and sexuality that no single academic department is able to answer, the program encourages an interdisciplinary approach to research and learning. The program includes faculty from the humanities, sciences, and social sciences who are appointed in Arts, Sciences & Engineering, the Eastman School of Music, the Margaret Warner Graduate School of Education and Human Development, the Simon Business School, the School of Nursing, and the School of Medicine and Dentistry. To view our current faculty associates and affiliates, please visit the SBAI website.

The Graduate Certificate in Gender, Sexuality, and Women’s Studies provides analyses of contemporary theoretical frameworks and methodologies; a historical perspective on gender, sexuality, and women’s studies within and across disciplines; a focus on issues of gender, sexuality, race, class, ability, ethnicity, and other axes of oppression; and connections between academic and nonacademic practices. It is designed to appeal to (1) matriculated graduate students who will apply for teaching positions at the post-secondary level (the certificate complements students’ credentials in their primary discipline by demonstrating scholarly competence in a related, interdisciplinary field and prepares students to offer a wider range of courses at employing institutions); and (2) nonmatriculated students who are interested in obtaining an interdisciplinary training in gender and women’s studies but who do not wish to commit to a full degree program. This training is appropriate for those expanding upon and updating their undergraduate education, preparing for further graduate study, and/or desiring to link their current occupations with recent developments in gender, sexuality, and women’s studies.

404. Feminist Film Theory
407. Carnal Speaking: Middle Eng
416. Restoration & 18th-C Drama
422. 19th Century British Novel
Emphasizing such novelists as Dickens, Thackeray, Eliot, and Hardy.

423. Madness, marriage & Monstrosity

425. Women, Cloth & Culture

426. History of Friendship

433. Race in American Fiction

443. Major Author: the Brontes

444. Mutilated Bodies & Discourse
‘Transnational sisterhood’ or cultural imperialism? Legitimate ritualized practice or outdated violent ritual? Genital cutting, female circumcision, female genital surgery? The controversy over this practice already begins with the act of its naming. If there seems to be a consensus about the physical violence imposed on the female body, why is it that western feminist discourse is suspected of perpetuating the mutilation African voices? This course seeks to provide an understanding of the context in which a fragmented ‘transnational sisterhood’ allows for a proliferation of mutilated discourses on mutilated postcolonial bodies. Readings and Films include Alice Walker (Warrior Marks), Florence Ayissi Fauziya Kassindja (Do They Hear You When You Cry), Maryse Conde and more critical and theoretical readings from African, French and North American authors. In English.

445. Contemporary American Memoir

446. Jane Austen & Contemporaries

453. Gender and Language

454. The Monstrous Feminine

456. Gender in Spanish-Amer Lit

458. Women Lives and Letters

465. Issues Film: documntry.mock
The course takes up particular concepts, ideas, and ideology in film, often spanning periods, nations, and genres.

467. Changing Genres of Erotica

468. Contemporary Jpn Culture
Issues of contemporary concern in Japan, including national, ethnic and racial identity; changing gender and sex roles; the family and generational conflict; immigration and work; the emperor system, war, and memory; cultural authenticity; and Japan's changing roles in Asia and in the world.

472. Gender & Sexuality
This course will examine literary, artistic, and theoretical representations of gender and sexuality as they have changed in the course of the 20 Century. The focus will be on texts from Western Europe and the US, but we will also consider other perspectives. From the New Women to French Feminists and transnational feminism. from homophile societies to ‘queer nation and gay marriage, from Sigmund Freud to Michel Foucault and Judith Butler, we will explore the contested and politically charged debates around gender and sexuality that have shaped our views of identity over the last century.

473. Sex & Gender in American City
This course will explore the role of gender and sexuality in American cities from the nineteenth century to the present. Through intensive reading and a research paper we will explore how gender and sexuality shaped the urban environment in the arenas of labor, politics, everyday life, and the built environment. We will also examine how the structures and cultures of American cities prescribed normative gender and sex roles on urban residents.

483. Orality, Language & Literacy
An inquiry into how literacy capability at different historical moments has affected the uses of texts, performances, and speech genres. Attention is given to literary, sacred, and secular texts.

487. US Latinos/Latinas
Introduction to U.S. Latino/a writing and culture in its rich geographic and ethnic diversity; Latinization of the American landscape; exile, immigration, cultural syncretism.

489. Assimilating Literary Lang

496. Intl Human Rights
What does it mean to be human? What political, economic, religious, social, or sexual rights might be part of different people’s working definitions? This course will look at both a) the historical development of conflicting theories of human rights and b) more contemporary debates about their ideal extent, their exercise, and their enforcement. Special topics will include debates over the meaning of the American and French Revolutions, the fight to design an International Declaration of Human Rights in the aftermath of World War II, the history of organizations such as Amnesty International, and the controversy around UN events such as the 1995 World Conference on Women in Beijing, the 2002 World Summit on Sustainable Development in Rio de Janeiro, and the 2000 and 2005 Millennium Summits in New York City.

591. Independent Study
Students interested in Independent Studies should contact the Women’s Studies Department.
W. Allen Wallis Institute of Political Economy

Professors Duggan, Rothenberg, Fey, Stone
Associate Professors Kalandrakis, Primo, Barelli
Assistant Professors Caetano, Frey, Montero, Paine

The Wallis Institute supports graduate training in political economy for students in the Department of Economics and the Department of Political Science. Prospective students who seek to specialize in this area should apply to the PhD program in one of those two departments. Students admitted to the economics or political science program are subject to the requirements of their program, and they may choose to take advanced graduate seminars in political economy. The Wallis Institute provides a two-course sequence in political economy taught by faculty from the parent departments. Students in economics may take the sequence and write a qualifying exam to fulfill the requirements for the political economy field, and students in political science may take the sequence as part of the requirements for the formal political theory field.

In addition to course offerings, the Wallis Institute runs a seminar series that allows Rochester faculty and students to present their work, and it brings in top researchers across the field from other departments. The institute sponsors post-docs and other visitors and encourages interaction with graduate students. Also, the institute funds a small grant program for students to work with faculty members conducting applied, empirical research. Finally, students are invited to attend an annual conference organized by the institute that continues to serve as a focal point of the political economy field.

The first course in the political economy sequence typically emphasizes foundational theory, and especially connections to the theory of social choice. The goal of the course is to give students in political economy a firm theoretical grounding for their work. The second course may cover a range of topics from elections to legislative policy and makes use of methods from formal modeling, computational analysis, or empirical methods. Content of the course may vary with the instructor. Also, the instructor may require students have sufficient background in game theory or other techniques. (Spring)

575. Political Economy I
Models-based course covering fundamental topics in theoretical political economy. Voting, electoral competition, special interest politics and political accountability. Highlights include institutional features shaping public policy and institutional design. Collective decisions viewed as outcomes of game played by individual decision-makers. Empirical motivations for and implications of the political economy models will be discussed.

582. Political Economy II
The course builds on the theoretical foundations of Political Economy I and delves into topics such as elections, voting, legislative policy making, and political development. The methodological focus of the course may range from formal modeling to computational analysis or empirical methods.
Writing, Speaking, and Argument

Professor Rossen-Knill (Executive Director)
Associate Professors Schaefer, Sloan (EAPP Director), Sydelnik (Associate Director), Tinelli, Wang
Assistant Professors Arbogast, Bayne, Gegg-Harrison, Hannum, Lee, Malloy, Mohn, Phillips, Towsley

The Writing, Speaking, and Argument Program (WSAP) in concert with faculty across the College, builds a strong community of undergraduate and graduate writers, speakers, and researchers. Effective communication—including critical thinking, problem solving, organization of ideas, and clarity and power of expression—is of enormous importance both in academic and professional settings. Writing, speaking, and argument enable us to discover, develop, test, and share our ideas. Through communication, we see the truth, utility, or beauty of what we know and make our knowledge have an impact on the world at large.

The Graduate Writing Project (GWP) supports graduate students from Arts, Sciences & Engineering at any stage in their program, working on any kind of academic writing and research, from abstracts and article submissions to theses and dissertations. We offer a range of services designed for graduate-student writers at the University, including writing groups, tutoring, writing boot camps, and writing workshops.

The WSAP also has several renewable teaching fellowships for those interested in designing their own version of WRT 105: Reasoning and Writing in the College, a theme-based, first-year writing course. All instructors accepted into our program will teach one section of WRT 105 in fall and the same course in spring and attend the program orientation at the end of August. The minimum commitment for this position is two years; however, successful performance is required for reappointment after the first year.

Additionally, the WSAP hires graduate students to become writing consultants. Consultants are graduate students from a variety of disciplines who offer writing tutoring to undergraduate and graduate student writers.

Graduate degrees are not offered through the program. Please check with the WSAP for information on other classes that may be open to graduate students.

451. The Rhetorical Sentence

Drawing on work in linguistics and rhetorical grammar (e.g., Halliday, Biber, Kolln, Hyland), this course investigates the sentence—its structure, its potential, and its limits in creating meaning. Students will learn about the form and function of “the sentence” and its parts, develop the ability to see patterns and possibilities within and across sentences, and create and analyze sentences of wildly different shapes. Assignments will regularly involve meaningful play with sentences. Through a final project, students will investigate some aspect of the sentence in extended discourse or discuss how knowledge of the sentence might be meaningfully integrated into a writing curriculum. This course is ideal for those interested in writing, writing education, or editing. Background in linguistics or grammar is not necessary. Open to undergraduates and graduate students.

571. Writing Pedagogy

572. Practicum in Teaching of Writing
Edmund A. Hajim
School of Engineering
& Applied Sciences

Administrative Officers
Wendi Heinzelman, PhD
Dean
Melissa Sturge-Apple, PhD
Dean of Graduate Studies for Arts, Sciences & Engineering
James M. Zavislan, PhD
Associate Dean of Education and New Initiatives

Full-Time Faculty
Govind P. Agrawal, PhD (Indian Institute of Technology)
Dr. James C. Wyant Professor of Optics
James Allen, PhD (Toronto)
John H. Dossauer Professor of Computer Science
Miguel Alonso, PhD (Rochester)
Professor of Optics
Mitchell Anthamatten, PhD (MIT)
Professor of Chemical Engineering
Riccardo Betti, PhD (MIT)
Robert L.McCarron Professor and Professor of Mechanical Engineering
Mark F. Bocko, PhD (Rochester)
Distinguished Professor of Electrical and Computer Engineering
Robert W. Boyd, PhD (California, Berkeley)
Professor of Optics
Thomas G. Brown, PhD (Rochester)
Professor of Optics
Laurel Carney, PhD (Wisconsin–Madison)
Marylou Ingram Professor of Biomedical Engineering
P. Scott Carney, PhD (Rochester)
Professor of Optics
Shaw-Horning Chen, PhD (Minnesota, Twin Cities)
Professor of Chemical Engineering
Eldred H. Chimowitz, PhD (Connecticut)
Professor of Chemical Engineering
Robert L. Clark, PhD (Virginia Tech)
Professor of Mechanical Engineering
Gilbert (Rip) Collins (Ohio State)
Dean's Professor and Professor of Mechanical Engineering
Diane Dalecki, PhD (Rochester)
Distinguished Professor of Biomedical Engineering
Chen Ding, PhD (Rice)
Albert Arendt Hopeman Professor of Engineering and Professor of Computer Science
Sandhya Dwarkadas, PhD (Rice)
Professor of Computer Science
James R. Fienup, PhD (Stanford)
Robert E. Hopkins Professor of Optics
Eby G. Friedman, PhD (California, Irvine)
Distinguished Professor of Electrical and Computer Engineering
Paul D. Funkenbusch, PhD (Michigan Technological)
Professor of Mechanical Engineering
Daniel Gildea, PhD (California, Berkeley)
Professor of Computer Science
Sheryl M. Gracewski, PhD (California, Berkeley)
Professor of Mechanical Engineering
Chunlei Guo, PhD (Connecticut)
Professor of Optics
Wendi Heinzelman, PhD (MIT)
Professor of Electrical and Computer Engineering
Lane Hemaspaandra, PhD (Cornell)
Professor of Computer Science
Michael Huang, PhD (Illinois, Urbana-Champaign)
Professor of Electrical and Computer Engineering
Jacob Jorné, PhD (California, Berkeley)
Professor of Chemical Engineering
Henry Kautz, PhD (Rochester)
Professor of Computer Science
Wayne H. Knox, PhD (Rochester)
Professor of Optics
John C. Lampropoulos, PhD (Harvard)
Professor of Mechanical Engineering
Jiebo Luo, PhD (Rochester)
Professor of Computer Science
James L. McGrath, PhD (Harvard/MIT)
Professor of Biomedical Engineering

Duncan T. Moore, PhD (Rochester)
Rudolph and Hilda Kingslake Professor in Optical Engineering Science and
Professor of Optics

Kevin J. Parker, PhD (MIT)
William F. May Professor of Electrical and Computer Engineering

Renato Perucchio, PhD (Cornell)
Professor of Mechanical Engineering

Chuang Ren, PhD (Wisconsin, Madison)
Professor of Mechanical Engineering

Jannick Rolland, PhD (Arizona)
Brian J. Thompson Professor of Optical Engineering and Professor of Optics

Lenhart Schubert, PhD (Toronto)
Professor of Computer Science

Michael Scott, PhD (Wisconsin, Madison)
Arthur Gould Yates Professor of Engineering and Professor of Computer
Science

Gaurav Sharma, PhD (North Carolina State, Raleigh)
Professor of Electrical and Computer Engineering

Roman I. Sobolewski, PhD (Polish Academy of Sciences)
Professor of Electrical and Computer Engineering

Carlos R. Stroud, Jr., PhD (Washington, St. Louis)
Professor of Optics

Gary W. Wicks, PhD (Cornell)
Professor of Optics

David R. Williams, PhD (California, San Diego)
William G. Allyn Professor of Medical Optics and Professor of Optics

J. H. David Wu, PhD (MIT)
Professor of Chemical Engineering

Matthew Yates, PhD (Texas, Austin)
Professor of Chemical Engineering

Xi-Cheng Zhang, PhD (Brown)
M. Parker Givens Professor of Optics

Danielle Benoit, PhD (Colorado, Boulder)
Associate Professor of Biomedical Engineering

Andrew J. Berger, PhD (MIT)
Associate Professor of Optics and Biomedical Engineering

Edward Brown, PhD (Cornell)
Associate Professor of Biomedical Engineering

Mujdat Çetin, PhD (Boston)
Associate Professor of Electrical and Computer Engineering

Regine Choe, PhD (Pennsylvania)
Associate Professor of Biomedical Engineering

Hanan Dery, PhD (Israel Institute of Technology)
Associate Professor of Electrical and Computer Engineering

Marvin Doyley, PhD (London)
Associate Professor of Electrical and Computer Engineering

Jonathan Ellis, PhD (Delft University of Technology, Netherlands)
Associate Professor of Mechanical Engineering

Zeljko Ignjatovic, PhD (Rochester)
Associate Professor of Electrical and Computer Engineering

Engin Ipek, PhD (Cornell)
Associate Professor of Electrical and Computer Engineering

Catherine Kuo, PhD (Michigan)
Associate Professor of Biomedical Engineering

Edmund Lalor (University College of Dublin)
Associate Professor of Biomedical Engineering

Amy Lerner, PhD (Michigan)
Associate Professor of Biomedical Engineering

Qiang Lin, PhD (Rochester)
Associate Professor of Electrical and Computer Engineering

Stephen McAlavey, PhD (Rochester)
Associate Professor of Biomedical Engineering

Jack G. Mottley, PhD (Washington, St. Louis)
Associate Professor of Electrical and Computer Engineering

Jong-Hoon Nam, PhD (Virginia Tech)
Associate Professor of Mechanical Engineering

Randal C. Nelson, PhD (Maryland)
Associate Professor of Computer Science

Alexander Shestopalov, PhD (Zelinsky Institute, Russia; Duke)
Associate Professor of Chemical Engineering

Daniel Stefankovic, PhD (Chicago)
Associate Professor of Computer Science

Anthony (Nick) Vamivakas, PhD (Boston)
Associate Professor of Optics

Muthuramakrishnan Venkitasubramaniam, PhD (Cornell)
Associate Professor of Computer Science

Hui Wu, PhD (California Institute of Technology)
Associate Professor of Electrical and Computer Engineering

James M. Zavislan, PhD (Rochester)
Associate Professor of Optics

Niaz Abdolrahim, PhD (Washington State)
Assistant Professor of Biomedical Engineering

Hussein Aluie, PhD (Johns Hopkins)
James P Wilmot Distinguished Assistant Professor of Mechanical Engineering

Mark Buckley, PhD (Cornell)
Assistant Professor of Biomedical Engineering

Jaime Cardenas, PhD (Alabama, Huntsville)
Assistant Professor of Optics

John Criswell, PhD (Illinois)
Assistant Professor of Computer Science

Liyanagamage (Ranga) Dias, PhD (Washington State)
Assistant Professor of Mechanical Engineering

Zhiyao Duan, PhD (Northwestern)
Assistant Professor of Electrical and Computer Engineering

M. Ehsan Hoque, PhD (MIT)
Stephen Biggar ’92 and Elisabeth Asaro ’92 Professor in Data Science and
Assistant Professor of Computer Science

Thomas Howard, PhD (Carnegie Mellon)
Assistant Professor of Electrical and Computer Engineering

Douglas Kelley, PhD (Maryland)
Assistant Professor of Mechanical Engineering

Ji Liu, PhD (Wisconsin)
Assistant Professor of Computer Science

Ross Maddox, PhD (Boston)
Assistant Professor of Biomedical Engineering

Gonzalo Mateos, PhD (Minnesota)
Assistant Professor of Electrical and Computer Engineering
Audio Music Engineering

Professor Bocko (Chair)
Associate Professors Ignjatovic, Mottley, Temperley
Assistant Professors Anderson, Duan, Lee
Instructor Roessner
Lecturer LaVaque

For students interested in pursuing graduate studies in audio and music engineering, Rochester offers a concentration in acoustics, audio, and music signal processing in both the MS and PhD electrical engineering graduate programs.

MS Program for Current Students

Current audio and music engineering (AME) students may choose to earn an MS degree in electrical and computer engineering with as little as one additional year of study following completion of the AME BS program.

AME seniors contemplating graduate work may consider the MS program offered by the electrical and computer engineering (ECE) department in which students earn a master’s degree in electrical engineering with a concentration in music acoustics and signal processing. This program provides for a smooth transition between undergraduate and graduate study.

Program enrollment is competitive and students must apply for admission before the spring of their senior year. Students may take up to 8 credit hours of graduate-level coursework in their senior year that could count toward their MS degree (if not used toward the BS degree requirements). Tuition scholarships for exceptionally qualified students are available for MS students in the Electrical Engineering Graduate Program.

Master’s and PhD

An MS and PhD degree with a concentration and research in acoustics, audio, and music signal processing is available through the Department of Electrical and Computer Engineering (ECE). For more information about these programs, please visit the ECE graduate overview page.

433. Musical Acoustics

460. Digital Programs & Prog I
Prerequisite: ESM students only

The course is intended to provide students a basic understanding of sound design, and working with sound for picture. The emphasis is on demonstrations and hands-on experience to enable students to gain a practical knowledge of sound and music production using computers. Topics include MIDI; synthesizers & samplers; recording and editing with Pro Tools and Logic Pro X; sound effect creation; foley & automatic dialog replacement; basic soundtrack composition; and working to picture. Many techniques are explored employing software and hardware based sound creation tools throughout the course. (Fall Spring)
461. Digital Program. and Prog II  
Prerequisite: ESM students only

This course is intended to provide students with a basic understanding of the process and the skills for creating music for picture. The course emphasizes hands-on experience where students gain practical skills in scoring to picture using computers and it features guest lectures by industry leading professionals, who will share their insights on creating music for TV Shows, Advertising, Movies, Gaming, Animation, and Industrial Work. Topics also include soft synthesizers, samplers and virtual instruments; recording and editing with Pro Tools and Logic; and sound design on audio workstations. Students will complete a number of projects throughout the course. (Fall Spring)

462. Audio for Gaming  
Prerequisite: Instructor approval required

The course is intended to provide students a basic understanding of audio for gaming. The emphasis is on demonstrations and hands-on experience to enable students to gain a practical knowledge of the integration of sound and music into video games using middleware. Students will primarily work with Wwise, Unity, Reaper, Pro Tools and Logic Pro X; Topics will include basic soundtrack composition for interactive; Advanced sound effect creation; foley; Dialog recording and editing; Working directly within a game environment; and audio for virtual reality. Supplementary software discussed will include FMOD, Unreal, Fabric, Nuendo, and Elias. The course will also feature guest lectures by industry leading professionals, who will share their experience and insights. (Fall)

471. Comp Models of Music Proc  
This course is designed for engineering and science students to learn the basic elements of music theory and analysis, but employing concepts and tools from digital signal processing, pattern classification, machine learning and data mining. Class requirements include weekly readings and programming assignments, and a final project in which students complete an analysis of a large-scale symphonic work combining their subjective aesthetic response to the piece with the computational analysis using the tools developed throughout the course. A knowledge of the rudiments of musical notation is helpful, but not a prerequisite. (Spring)

472. Audio Signal Proc  
Prerequisites: ECE 114 and basic Matlab programming, ECE 241 or other equivalent signals and systems courses.

This course is a survey of audio digital signal processing fundamentals and applications. Topics include sampling and quantization, analog to digital converters, time and frequency domains, spectral analysis, vocoding, digital filters, audio effects, music audio analysis and synthesis, and other advanced topics in audio signal processing. Implementation of algorithms using Matlab and on dedicated DSP platforms is emphasized. (Spring)

473. Audio for Gaming  
Prerequisite: ESM only

The course is intended to provide students a basic understanding of audio for gaming. The emphasis is on demonstrations and hands-on experience to enable students to gain a practical knowledge of the integration of sound and music into video games using middleware. Students will primarily work with Wwise, Unity, Reaper, Pro Tools and Logic Pro X; Topics will include basic soundtrack composition for interactive; Advanced sound effect creation; foley; Dialog recording and editing; Working directly within a game environment; and audio for virtual reality. Supplementary software discussed will include FMOD, Unreal, Fabric, Nuendo, and Elias. The course will also feature guest lectures by industry leading professionals, who will share their experience and insights.

477. Computer Audition  
Prerequisites: ECE 246/446 or ECE 272/472 or other equivalent signal processing courses, and Matlab programming. Knowledge of machine learning techniques such as Markov models, support vector machines is also helpful, but not required.

Computer audition is the study of how to design a computational system that can analyze and process auditory scenes. Problems in this field include source separation (splitting audio mixtures into individual source tracks), pitch estimation (estimating the pitches played by each instrument), streaming (finding which sounds belong to a single event/source), source localization (finding where the sound comes from) and source identification (labeling a sound source).

481. Sound Design

491. Master’s Reading
Biomedical Engineering

Assistant Professors Buckley, *Glading, *Howard, *Hunter, Maddox

Clinical Director of Center for Medical Technology & Innovation *Rosero
Associate Director for Regulatory Support Services in CTSI *Adamo

Affiliated with both the Edmund A. Hajim School of Engineering and Applied Sciences and the School of Medicine and Dentistry, the Graduate Program in Biomedical Engineering at the University of Rochester has been designed to emphasize the application of engineering skills to biomedical problem solving at both the master’s and doctoral level. Our educational program provides training to ensure a solid foundation in both engineering principles and in biological sciences.

Biomedical engineers can choose from a wide range of careers, from basic research to clinical applications. This is reflected in the diverse talents and interests of the BME faculty, many with affiliations in both engineering and clinical departments. Our research strengths include, but are not limited to, biomedical imaging, neuroengineering, biomedical optics, biomechanics, biomaterials, biotechnology, and cell and tissue engineering, among others.

The Center for Medical Technology & Innovation provides a cross-campus collaborative environment that unites the talents and resources of the Edmund A. Hajim School of Engineering & Applied Sciences and the School of Medicine and Dentistry with industry partners to improve clinical care. At the heart of this mission is a one-year Medical Technology & Innovation master’s degree program in biomedical engineering focused on medical device development and commercialization.

With facilities in both the Robert B. Goergen Hall for Biomedical Engineering and Optics and the University of Rochester Medical Center in close proximity, our graduate program offers state-of-the-art dedicated training laboratories, close individual attention and faculty mentoring, and a growing and welcoming learning community of friends and future colleagues.

Further information about BME-related research at the University of Rochester, including our current admission and program requirements, can be found on the web at www.bme.rochester.edu or by writing to University of Rochester, Director of Graduate Studies, Department of Biomedical Engineering, Robert B. Goergen Hall, Box 270168, Rochester, NY 14627-0168.

* Primary appointment in another department

404. Computational Methods Applied to Biological Systems
The aim of this class is to gain experience solving analytically intractable research problems using computational methods. At the beginning of the course, general numerical analysis topics are reviewed. The rest of the course is oriented toward projects. Examples will be drawn from problems of biological systems.

411. Cellular & Molecular Bio Found
Molecular biology, biochemistry, and genetics that are required to understand the biomedical and broader biological issues that affect our lives.

412. Visco in Bio Tissues
Viscoelastic materials have the capacity to both store and dissipate energy. As a result, properly describing their mechanical behavior lies outside the scope of both solid mechanics and fluid mechanics. This course will develop constitutive relations and strategies for solving boundary value problems in linear viscoelastic materials. In addition, the closely-related biphasic theory for fluid-filled porous solids will be introduced. An emphasis will be placed on applications to cartilage, tendon, ligament, muscle, blood vessels, and other biological tissues. Advanced topics including non-linear viscoelasticity, composite viscoelasticity and physical mechanisms of viscoelasticity will be surveyed.

416. Speech On the Brain

418. Intro to Neuroengineering
Prerequisites: BME 260, strong math/computing skill recommended or permission of instructor
Quantitative studies of neural responses at the cellular, circuit, and systems levels. Analytical and computational modeling of neurons, including nonlinear behavior of neurons and neural circuits. Neural coding of information by single cells or neural populations. Applications of neural networks. Techniques for recording and monitoring neural activity, and applications of neural recording and stimulation to neural prostheses. (Fall)

420. Biomedical Nanotech
This course is designed to provide students with detailed knowledge of the principles of nanotechnology and their applications in the biomedical field. Topics of study will include synthesis & assembly of nanoscale structures, lithography, and nanobiomaterials. Students will focus on biomedically-relevant topics such as cancer treatment, bone disorder, diabetes; and learn how nanotechnology is helping diagnose, treat, and understand these medical disorders. Recent innovative research in the biomedical field will be highlighted during discussions of the latest journal articles. At the end of the course, students will have an appreciation of the enormous potential of biomedical nanotechnology, its current, and future applications.

425. Human Neurophys Measurement
This course introduces students to studies of human brain function using non-invasive methods.
428. Physiological Control Systems
**Prerequisite: permission of instructor**
This course introduces students to the theory and practice of control systems engineering. Topics include frequency domain modeling, time domain stability, transient and steady-state error analysis, root locus and frequency response techniques and feedback system design. Emphasis is placed on analyzing physiological control systems, but the concepts and design techniques are applicable and applied to a wide variety of other systems including mechanical and electrical systems. (Spring)

This interactive course will offer students exposure to intellectual property (IP), patenting processes and regulatory pathways for new medical innovations. Students will learn the terminology, processes and challenges involved in FDA regulations, and the protection and evaluation of intellectual property for medical innovations. Differences between Regulatory Affairs and Regulatory Science will be highlighted with opportunities to work on Regulatory Science in a project setting. An emphasis will be placed on ways that knowledge of prior art and regulatory barriers can optimize concept selection, and early phase planning to best identify projects suitable for commercialization. (Spring)

432. FDA & IP Commercialization: Implementing FDA Requirements and Practical Steps to Commercializing Medical Products
This interactive course focuses on Intellectual Property (IP) and FDA regulatory pathways for medical innovations. Emphasis will be placed on how knowledge of IP protection and evaluation, and regulatory barriers can optimize design, testing and commercialization strategies. Building on BME 431 material, students will learn about the processes and barriers to bringing medical products through clinical trials. Instruction will include lectures, case studies, guest speakers and integrated assignments that will ask students to explore examples of IP and regulatory challenges, successes and failures. Lectures on regulatory and IP topics will alternate so students can appreciate the difficulty presented by balancing these two challenges in the innovation process. Some assignments may be tailored to individual students’ research, design or work concentration areas. A project conducted in partnership with the FDA will provide students an opportunity to submit a mock pre-Submission to the FDA for review. (Spring)

442. Microbiomechanics With Microfluidics
**Prerequisite: permission of instructor**
This course covers a range of topics in mechanics and biophysics essential to the practice of biomedical engineering at the smallest length scales. The course is taught in two parts. The first half focuses on basic principles such as diffusion and the physical and kinetic properties of biomolecules. This section ends with an integration of these concepts in the study of molecular machines in biology. The second half of the course focuses on microfluidics including basic theory, COMSOL modeling and microfabrication of devices. The course ends with each student building a unique microfluidic system with mentorship from faculty, staff or advanced graduate students. Enrollment is limited. (Spring)

445. Biomedical Ultrasound
**Prerequisites: CHM 131, CHM 132, PHY 121, PHY 122, MTH 161, MTH 162, Biomechanics and BIO 110 OR permission of instructor**
This course provides a background in biomedical ultrasound, including basic material properties, specifics on ceramics, polymers and metals used in the body, and special topics related to biomaterials including tissue engineering, biological responses to implanted materials, and drug delivery. (Spring)

448. Controlled Release Systems
This course will cover the principles, strategies, and materials used in controlled drug delivery systems.

451. Biomedical Ultrasound
The physical basis for the use of high-frequency sound in medicine (diagnosis, therapy, and surgery) and biology. Topics include acoustic properties of tissues, sound propagation (both linear and nonlinear) in tissues, interactions of ultrasound with gas bodies (acoustic cavitation and contrast agents), thermal and non-thermal biological effects of ultrasound, ultrasonography, dosimetry, hyperthermia and lithotripsy. Graduate students will have extra assignments. (Spring)

452. Medical Imaging: Theory & Implementation
**Prerequisite: ECE 242**
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Special attention is given to the Fourier transform relations and reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI. (Spring)

453. Advanced Biomedical Ultrasound
**Prerequisite: BME 451 or permission of the instructor**
This course investigates the imaging techniques applied in state-of-the-art ultrasound imaging and their theoretical bases. Topics include linear acoustic systems, spatial impulse responses, the k-space formulation, methods of acoustic field calculation, dynamic focusing and apodization, scattering, the statistics of acoustic speckle, speckle correlation, compounding techniques, phase aberration correction, velocity estimation, and flow imaging. A strong emphasis is placed on readings of original sources and student assignments and projects based on realistic acoustic simulations. (Fall)

455. Translational Biomedical Optics
This course will focus on the macroscopic biomedical optics techniques (e.g. diffuse optical spectroscopy and tomography, photoacoustic tomography) with high potentials for clinical translation. Students will learn the aspects of instrumentation design, analytic and numerical approaches for optical data analysis, and validation of new technologies in the clinical setting. (Spring)
458. Human Anatomy
The course analyzes the structural composition of the human body from cellular to organ levels. The goal is to provide a foundation in human anatomy appropriate for students interested in the bioscience and health care professions (e.g., nursing, physical therapy, medicine, bioengineering). Learning objectives will be achieved through a combination of lecture and hands-on (laboratory) approaches, reinforced by clinical examples. Graduate students (BME458) will participate in small group discussions of clinical case studies, topic appropriate biomedical devices, and prepare a term paper on the subject of their choice from the topics listed at the end of the syllabus.

459. Applied Human Anatomy
Prerequisite: Any introductory biology course.
This course analyzes the structural composition of the human body from cellular to organ levels. The goal is to provide a foundation in human anatomy appropriate for students interested in the bioscience and health care professions (e.g., nursing, physical therapy, medicine, bioengineering). Learning objectives will be achieved through a combination of lecture and hands-on (laboratory) approaches, reinforced by clinical examples and analysis of how biomedical devices interface with anatomical structures. In addition, students will participate in small group discussions of clinical case studies, make group presentations of topic appropriate biomedical devices, and prepare a term paper on the subject of their choice selected from a list of topics generated by the instructor. (Spring)

460. Quantitative Physiology
A quantitative, model-oriented approach to physiological systems is presented. Topics include muscle and nerve tissue, the cardiovascular system, the respiratory system, the renal system, and a variety of neural systems

462. Cell & Tissue Engineering
This course teaches the principles of modern cell and tissue engineering with a focus on understanding and manipulating the interactions between cells and their environment. After a brief overview of Cell and Tissue Engineering, the course covers 5 areas of the field. These are: 1) Physiology for Tissue Engineering; 2) Bioreactors and biomolecule production; 3) Materials for Tissue Engineering; 4) Cell Cultures and bioreactors and 5) Drug Delivery and Drug Discovery. Within each of these topics the emphasis is on analytical skills and instructors will assume knowledge of chemistry, mass transfer, fluid mechanics, thermodynamics and physiology consistent with the Cell and Tissue Engineering Track in BME. In a term project, graduate students must identify a technological need and present orally and in writing a proposal to meet the need. (Spring)

465. Cell Adhesion
This course covers quantitative aspects of receptor mediated cell adhesion: Kinetic descriptions, role of mechanical force. Types of adhesion molecules are reviewed with an emphasis on inflammation. (Spring)

466. Bioprocess Engineering
This course will explore the bioprocesses involved in producing a biopharmaceutical product (therapeutic proteins, cell therapy products, and vaccines). The course will take a stepwise journey through a typical production process from the perspective of a Bioprocess Engineer, starting with cell culture and moving downstream through purification and final fill. Engineering concepts involved in bioreactor design and control, cell removal/recovery operations, and protein purification will be examined. The course will also provide an introduction to the analytical methods used to test biopharmaceutical products for critical quality attributes. The role of the regulatory agencies, like the US Food and Drug Administration, and the regulations that govern the industry will be introduced throughout the course in the context of the bioprocess to which they relate. Graduate students will need to complete a semester-end project in order to receive graduate credit for the course.

467. Models & Simulations of BME Systems
Prerequisites: BME 230 and 221 or permission of instructor
Introduction to analytical modeling and computational simulations of systems. Examples will include cardiovascular, respiratory, muscle, neural and population models. Analytical models for several physiological systems will be studied, and simulations will be written in Matlab. (Fall)

470. Biomedical Microscopy
Prerequisite: permission of instructor
This course covers the principles and practice of light microscopy as applied to biological and medical questions. Topics include basic light microscopy, epifluorescence, confocal and multiphoton laser-scanning microscopy, and selected methods such as CARS, FRET, FRAP, FCS, etc. (Fall)

474. Biomed Sensors,circuits & Intr
Prerequisite: permission of instructor
Course will cover circuits and sensors used to measure physiological systems at an advanced level. Both signal conditioning and sensor characteristics will be addressed. Topics will include measurement of strain, pressure, flow, temperature, biopotentials, data acquisition, and electrical safety. The laboratory will focus on the practical implementation of electronic devices for biomedical measurements. (Spring)

483. Biosolid Mechanics
Application of engineering mechanics to biological tissues including bone, soft tissue, cell membranes, and muscle. Realistic modeling of biological structures, including the heart, cells, and musculoskeletal tissues. Experimental methods and material models. (Fall)
485. Cell & Membrane Mechanics
Prerequisites: Some background in mechanics and cell biology recommended.

This course focuses on the fundamental science underlying the mechanical behavior of cell membranes and the formation of adhesive contacts between cells and between cells and substrates. Our approach is to explore mathematical descriptions of the physical properties of biomembrane structures as well as the physics and chemical basis of cell adhesion. Basic aspects of the structure and composition of cell membranes and the classes of adhesion molecules found on cells are reviewed as a basis for the mathematical treatments. (Spring)

486. Finite Elements
Prerequisites: ME 226 Finite elements and programming capability in FORTRAN, C, or C++. MATLAB

This course provides a thorough grounding on the theory and application of linear finite element analysis in solid and structural mechanics and related disciplines. Topics: matrix structural analysis concepts and computational procedures, review of linear elasticity, variational methods and energy formulation, weighted residual methods and Galerkin techniques, shape functions based on assumed displacements, isoparametric formulation, FE solution of heat transfer problems, global analysis aspects, error estimation and convergence. MATLAB is used extensively throughout the course (Fall)

487. Nonlinear Finite Element

The theory and application of nonlinear FE methods in solid and structural mechanics, and biomechanics. Topics: review and generalization of linear FE concepts, review of solid mechanics, nonlinear incremental analysis, FE formulations for large displacements and large strains, nonlinear constitutive relations, incompressibility and contact conditions, hyperelastic materials, damage plasticity formulation, solution methods, explicit dynamic formulation.

489. Biosensors

This course introduces students to the highly interdisciplinary field of biosensors, with focus on electrochemical transduction. After an overview of the fundamental principles, the course will introduce various strategies to apply the scientific theory and mechanisms to practical issues such as immunoassays, detection of DNA mutation or environmental toxins, metabolic activity, and in-vivo neuronal signal monitoring. The students will be exposed to recent publications that highlight key advances in this field and learn how various chemical, biological and engineering concepts are used in synergy to achieve state-of-the-art sensing of important biological molecules. Emphasis is placed on active participation by students, including literature presentations, critical evaluation of articles, concise technical writing and in-depth discussions.

491. Master’s Reading in BME

493. Master’s Essay

494. Masters Internship

495. Master’s Research in BME

496. Current Research Seminars

513. Introduction to FMRI: Imaging, Computational Analysis and Neural Representations
Prerequisite: Graduate-level math course.

The core focus of the course will be on how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing. Some of the questions that the course will address include: 1) The basic fMRI signal just shows activation in different parts of the brain. How can we get from that to addressing questions about neural representations and neural information processing? 2) Ways of relating neural activation to behavioural performance. Can fMRI provide information over and above what can be obtained from behaviour alone? 3) Standard fMRI analysis using the General Linear Model, including preprocessing steps. 4) Multivariate fMRI analysis using machine learning approaches. There will also be a component, about 20% of the class, on the big-picture aspects of MRI physics and physiology which make fMRI possible. (Fall)

515. Advanced Topics in Neural Control of Movement
Prerequisite: NSC 531 or permission of instructor.

This course investigates the neural control of movement beginning with an understanding of muscle properties and mechanisms of contraction. The course continues with an exploration of important conceptual and theoretical issues in the control of movement: the "degrees of freedom" problem and possible solutions, locomotion and central pattern generators, and the roles of cortex and brainstem in motor control. (Spring)

535. Med Device Design

This course builds on clinical observations and guides the process of selection of an unmet clinical need for further design and development. Teams will refine observed needs, then use brainstorming and prototyping techniques to develop potential concepts. Six Sigma tools will be used to guide design decisions and clarify design requirements. Both oral and written communication skills will be developed.

589. Writing Proposals in BME

This course covers the essential aspects of organization and content for writing formal scientific proposals. Open to second-year Ph.D. candidates. (Spring)

591. PhD Readings in BME

592. Spec Topics: Mechanobiology

This course will read and critique journal articles with a primary focus on current research in mechanobiology, including
mechanoregulation of stem cell function and mechanisms of
mechanotransduction. The philosophy behind this course is
that learning is a life-long process that is most effective (and
enjoyable!) when independently motivated. Thus, the course
is structured to teach critical thinking skills and the ability to
independently learn about new research areas from reading
scientific literature.

593. Laboratory Rotations in BME
Attend seminars first half of the semester and then students
rotate in at least 3 different labs during the first year of graduate
study to learn of the diversity of research opportunities for Ph.D.
research. (Spring)

594. Internship Research

594P. Internship Research Part-Time

595. PhD Research

595A. PhD Research in Absentia

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Master’s Dissertation

897A. Masters in-Absentia

899. Master’s Dissertation

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

997A. Doct Dissertatn in Absentia

999. Doctoral Dissertation

999A. Doct Dissertatn in Absentia

999B. PhD in-Absentia Abroad

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Rochester Center for Biomedical Ultrasound

Director: Diane Dalecki (Biomedical Engineering)
Associate Director: Deborah J. Rubens (Imaging Sciences)

Affiliated University of Rochester departments: anesthesiology,
biomedical engineering, biophysics/biochemistry, cardiology,
dermatology, earth and environmental sciences, electrical and
computer engineering, emergency medicine, imaging sciences,
immunology/rheumatology, mechanical engineering, obstetrics
and gynecology, pathology, pharmacology and physiology, radia-
tion oncology, surgery, urology, and vascular medicine.

The Rochester Center for Biomedical Ultrasound (RCBU),
created in 1986, unites professionals from both the medical and
engineering communities. The RCBU includes nearly 100 pro-
essionals from a diverse selection of departments at the Univer-
sity of Rochester, as well as colleagues from Rochester Institute
of Technology and General Hospital. RCBU laboratories are
advancing the use of ultrasound in diagnosis and discovering
new applications of ultrasound in medicine and biology. The
RCBU does not offer independent degree programs. Rather,
students can pursue advanced degrees (MS and PhD) in various
departments of engineering and applied sciences with a focus
on biomedical ultrasound. RCBU laboratories provide a rich
environment for graduate training in biomedical ultrasound,
and students have access to state-of-the-art facilities for their
research. A wide range of course offerings across multiple dis-
ciplines complements the rich environment for research in bio-
medical ultrasound. The Center sponsors seminars, workshops,
a journal club, and courses for the advancement of diagnostic
and therapeutic ultrasound that are announced to the greater
ultrasound community throughout the year. Graduate students
can get involved in the Center by indicating an interest in related
research, attending the regular Center seminars, journal clubs,
and workshops, and requesting an assignment as a research assis-
taxt as projects become available.

Visit the RCBU website at www.rochester.edu/rcbu.
Laboratory for Laser Energetics

The Laboratory for Laser Energetics (LLE) is a unique national resource for advanced research and education related to the application of high-power lasers. The Laboratory has the five-fold mission to (1) conduct research in inertial confinement fusion and high-energy-density phenomena; (2) provide education and training at the graduate and undergraduate levels in electrooptics, plasma physics, high-powered lasers, and nuclear fusion technology; (3) develop new technology and materials in support of the national laser-fusion program; (4) conduct basic physics experiments; and (5) operate the National Laser Users’ Facility.

LLE does not offer any degree programs. Graduate students join the Laboratory by registering in one of the graduate degree programs within the University and by indicating a preference for research at the laboratory. Currently, students working at the LLE are enrolled in the Departments of Mechanical, Electrical and Computer, or Chemical Engineering; Physics and Astronomy; Chemistry; Biophysics; or The Institute of Optics. The academic department chosen by the student determines the course and examination requirements for the PhD degree.

Self-supported research laboratories are important adjuncts to the academic departments in a relatively small school of engineering. If the research can be successfully integrated with undergraduate and graduate education, such laboratories can compensate for the economies of scale that exist in large universities. They can do much to provide the costly technological infrastructure that is essential for both education and research. The 22 department-based professors, 70 graduate students, and 55 undergraduates involved in the Laboratory’s research program in various ways illustrate this important synergism.

The Laboratory also has a small number of postdoctoral appointments available for one- or two-year periods. Candidates for postdoctoral fellowships should apply no later than January of the year in which they seek the post.

Qualified undergraduates enrolled in a degree program offered by the Hajim School of Engineering and Applied Sciences or the Department of Physics and Astronomy are eligible to participate in the Laboratory’s programs during their junior or senior year. Undergraduate candidates apply directly to the Laboratory’s associate director for academic affairs for appointments as research trainees.

Chemical Engineering

Associate Professors Foster, Kelley, Shostopalov
Assistant Professors Porosoff, Tenhaeff, White
Joint Appointments: Professors Harding, Rothberg, Shapir;
Associate Professor Benoit

Through experimentation, theory, and computation, chemical engineers apply biological, chemical, and physical principles to contemporary problems in biotechnology, materials, energy, and the environment. The chemical engineering faculty, postdoctoral research associates, and graduate students conduct research at the forefront of modern chemical engineering. Research strengths include advanced materials, biochemical engineering, nanoscale science and engineering, and research applied to energy and environmental issues. The applications of the research are far reaching and examples include new treatments for diseases, optoelectronic materials for flat panel displays, fuel cell development, pollution prevention, and development of new materials to be used in laser fusion. The interdisciplinary nature of chemical engineering research manifests itself in active collaborations with the Departments of Chemistry, Optics, Physics, and Electrical and Computer Engineering; the School of Medicine and Dentistry; and the Laboratory for Laser Energetics.

PhD Program

To educate a new generation of chemical engineers with unique interdisciplinary skills, students earning PhD degrees in chemical engineering are encouraged to select thesis topics falling within materials science, alternative energy, or biotechnology. Students carrying out research in these areas have the opportunity to be associated with a wide range of funded projects that provide thesis topics designed to meet individual interests and career plans. Full-time PhD students receive competitive graduate fellowships or research assistantships comprising an annual stipend plus full coverage of graduate tuition. Normally students begin their graduate studies in the fall semester. The first two semesters are devoted primarily to graduate courses selected in consultation with their thesis advisors. Consistent with the interdisciplinary emphasis, students are encouraged to take courses in chemical engineering and in other science and engineering graduate programs across the campus. The coursework is designed not only to furnish a foundation for thesis research but also to prepare students for a dynamic professional career upon graduation. As part of their educational experience, all PhD students are expected to provide undergraduate teaching assistance during the first two semesters. At the end of the second semester in residence, students take a PhD preliminary examination as a transition from classroom to full-time research, the formal basis for admission to PhD candidacy is a qualifying examination, taken before the third year in residence, in which students defend a written proposal for thesis research. To earn a PhD degree, students must complete a program of study of 90 credit hours (or 60 credit hours beyond the MS degree) consisting of a minimum of 30 credit hours of formal coursework (or 18 hours of formal coursework beyond the MS degree) and the balance of credit hours earned
through reading and/or research courses. The formal courses must include four “core” chemical engineering courses as described below. On average it takes five years to complete all the PhD degree requirements, which include successful defense of a dissertation presenting significant technical contributions to the field.

**MS Program**

The Master of Science degree may be pursued on either a full-time or part-time basis. Graduate students choosing Plan A complete a thesis, while Plan B MS students follow a formal coursework/non-thesis option.

**MS Program (Plan A)**

All students who pursue the MS degree with thesis (Plan A) are expected to earn 30 hours of credit of which a minimum of 18 and a maximum of 24 hours should be formal coursework acceptable for graduate credit. The balance of credit hours required for the degree is earned through MS reading and/or research courses (CHE 491/495). Satisfactory defense of a written master’s thesis is also required for the degree, independent of satisfactory completion of the research courses (CHE 495).

**MS Program (Plan B)**

All students who pursue the MS degree without thesis (Plan B) must earn a minimum of 32 credits of coursework acceptable for graduate credit. At least 18 of these credits should be taken from courses within the department. Overall, no more than six credits towards degree may be earned by research and/or reading courses. The additional courses in the Plan B program (over Plan A) are intended to compensate for the elimination of a thesis as a degree requirement. Students earning a Plan B are required to pass a comprehensive written exam towards the end of their program. This is intended to ensure some breadth in their technical education, consistent with the core course requirements. Students should consult the graduate program administrator when they are ready to schedule this exam.

**Note:** For both the Plan A and B degree options, at least 12 of the 18 hours of formal course requirement must be at the 400 level or above. The formal courses must also include four “core” chemical engineering courses as described below.

**Professional Master of Science Degree**

The objective of this degree is to provide interested students with an advanced degree in chemical engineering that at its core requires a significant period spent in an industrial setting working on an advanced technical project identified by the industrial sponsor and a department faculty member. The professional MS degree is earned through a combination of advanced coursework and a project report related to the industrial project worked on by the student.

**Degree Requirements**

All students who pursue the professional MS degree with project are expected to earn 30 hours of credit of which at least 18 should be formal coursework acceptable for graduate credit. The balance of credit hours required for the degree is earned through the industrial project performed by the student at the industrial location and evaluated by the faculty advisor in concert with the industrial supervisor. These credits are graded as independent study/research credits.

**Biochemical Engineering Option**

Students in chemical engineering have the option of replacing the MS degree (Plan B) requirements with 32 hours of coursework to include the following specially designed sequence of requirements in biochemical engineering: BIO 408, MBI 445, and CHE 469, plus requirements mentioned for the MS degree (Plan B).

All students choosing the biochemical engineering option must demonstrate competency in the undergraduate prerequisite subject matter including genetics, biochemistry, mathematics, transport phenomena, and separation processes.

**Core Course Requirements**

- Advanced transport phenomena (CHE 441) (or petition to take CHE 431)*
- Thermodynamics and statistical mechanics (CHE 485) (or petition to take CHE 443 and 444)*
- Applied Mathematics (CHE 400)
- Advanced Kinetics and Reactor Design (CHE 461)

**400. Applied Boundary Value Prob**

See ME 201 for course description (Fall)

**413. Engineering of Soft Matter**

*Prerequisites: CHM 203 (or equivalent) and CHE 225 or CHM 251 (or equivalent).*

This course will provide an overview of several contemporary research topics pertaining to structured organic materials. Lectures will focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures will introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials. Homework assignments and a brief technical presentation will be required. Advanced undergraduate students are welcome. OFFERED EVEN YEARS (Spring)

**414. Math Meth of Optics & Phy**

See OPT 411 for course description

**418. Statistical Mechanics**

* It will be up to the student to determine if they need to petition for a change to a course and to use the standard chemical engineering petition form.
**420. Biomedical Nanotech**
See BME 420 for course description

**425. Thermodynamics I**

**431. Chemical Reactor Design**
This course combines the concepts of mass balances, reaction rates, stoichiometry, and chemical equilibrium to introduce the fundamentals of chemical reactor design. Isothermal, uncatalyzed homogeneous reactions are considered initially, but more complex reactions, including heterogeneous, catalyzed reactions and biological reactions are also considered. Approaches to kinetic data acquisition and analysis techniques are presented, and then combined with knowledge of reaction mechanisms or the pseudo-state hypothesis to develop nonelementary rate laws. The course ends with nonisothermal reactor design. (Fall Spring)

**432. Controlled Release Systems**
See BME 432 for course description

**441. Advanced Transport Phenomenon**
Prerequisites: Graduate Student standing (or permission from instructor)

This course will acquaint the student with important topics in advanced transport phenomena (momentum, heat and mass transport). Topics include laminar and turbulent flow, thermal conductivity and the energy equation, molecular mass transport and diffusion with heterogeneous and homogeneous chemical reactions. Focus will be to develop physical understanding of principles discussed and with emphasis on chemical engineering applications. In addition to the text, the student will be exposed to classic and current literature in the field. (Fall)

**443. Fluid Dynamics**

**444. Heat & Mass Transfer**

**447. Liquid-Crystal Materials and Optical Applications**
This course will introduce the student to the physical, chemical and optical properties of liquid crystals (LC) that are the basis for their wide and successful exploitation as optical materials for a broad variety of applications in optics, photonics and information display. Topics to be presented include: origins of LC physical properties in thermotropic and lyotropic materials as a function of chemical structure, influence of these structure-property relationships on macroscopic organization in LC mesophases, and the effect of molecular ordering and order parameter on properties of special significance for device applications. Operating principles for LC devices in a wide variety of applications will be described, including passive and tunable/switchable polarizers, wave plates, filters, information displays and electronic addressing, electronic paper, color-shifting polarizing pigments, optical modulators, and applications in photonics and lasers (Fall)

**448. Controlled Release Systems**
See BME 448 for course description

**454. Interfacial Engineering**
Prerequisite: CHE 225

Lectures on the fundamentals of colloids and interfaces, systems with high interfacial area, and their role in modern processes and products. Topics include interfacial tension, contact angle, adsorption, surfactants, miscelles, microemulsions, and colloidal dispersions. Techniques for formation and characterization of interfaces and colloids will be reviewed. (Spring)

**455. Thermodynamics & Stat Mech**
Please see CHM 455 for the course description.

**458. Electrochemistry of Fuel Cells and Batteries**
The course will concentrate on presenting the principles of electrochemistry and electrochemical engineering, and the design considerations for the development of fuel cells capable of satisfying the projected performance of an electric car. The course is expected to prepare you for the challenges of energy conversion and storage and the environment in the 21st century. Course is offered October 23 - December 11.

**460. Solar Cells**
This course will introduce students to the basics of photovoltaic devices: physics of semiconductors; pn junctions; Schottky barriers; processes governing carrier generation, transport and recombination; analysis of solar cell efficiency; crystalline and thin-film solar cells, tandem structures, dye-sensitized and organic solar cells. Students will learn about current photovoltaic technologies including manufacturing processes, and also the economics of solar cells as an alternative energy source. Critical analysis of recent advances and key publications will be a part of the course work. (Fall)

**461. Advanced Chemical Kinetics**
This course will acquaint the student with advanced topics in chemical kinetics and reactor design. The first half of the course will focus on kinetics from a molecular point of view, including kinetic theory of gases, collision theory and activated complex theory. The second half of the course will transition into reactor design, with topics including surface reactions and catalysis, effects of transport limitations on reaction rate and non-ideal flow in reactors. The course will conclude with emphasis on current literature in the field including applications of heterogeneous catalysis, electrocatalysis and photocatalysis. (Fall)

**462. Cell & Tissue Engineering**
Teaches the principles of modern cell and tissue engineering with a focus on understanding and manipulating the interactions between cells and their environment. After a brief overview of Cell and Tissue Engineering, the course covers 5 areas of the field. 1) Physiology for Tissue Engineering; 2) Bioreactors and
biomolecule production; 3) Materials for Tissue Engineering; 4) Cell Cultures and bioreactors and 5) Drug Delivery and Drug Discovery.

464. Biofuels
This course will provide the student with a grounding in the fundamental principles of biofuels, including their sources, properties, and the biological and chemical processes by which they are made. (Fall)

465. Sustainable Chemical Processes
Prerequisites: Organic Chemistry I; Chemical Kinetics and Reactor Design
Elements of sustainable chemical processes. Generation of transportation fuels and chemical platforms from renewable resources--e.g. lignocellulose, algae, and carbon dioxide--for production of bulk and fine chemicals traditionally derived from petroleum. Use of environmentally benign solvents--e.g. ionic liquids, supercritical carbon dioxide, fluorous solvents, and liquid polymer--for reactions and separations. Chemical reactions activated by unconventional means--e.g. ball milling, microwave heating, and ultrasound irradiation--requiring minimum energy, catalyst, and solvent. Chemical and enzymatic catalysis enhanced by process integration to minimize the need for product separation and purification. “Click reactions” applied to the synthesis of peptides and advanced materials. Microreactor technologies to maximize heat & mass transfer, reaction rate, product yield and selectivity, in addition to facilitating process control, optimization, and scale-up. (Spring)

466. Bioprocess Engineering
See BME 266 for course description

469. Biotechnology & Bioengineering
The life science and engineering principles underlying biotechnology processes; established biotechnology processes including microbial and enzyme conversions, metabolic pathways, and fermentation kinetics; tools for biotechnology development including the recombinant DNA and monoclonal antibody techniques; emerging areas at the forefront of biotechnology, including immune technology and tissue and organ cultures. (Spring)

476. Polymer Synthesis and Characterization
Prerequisite: CHM 203
An introduction to polymerization reaction mechanisms. The kinetics of commercially relevant polymerizations are emphasized along with a discussion of important, contemporary polymerization schemes. Approaches to functionalize polymers and surface-initiated polymerizations will also be covered. An overview of polymer characterization techniques, emphasizing compositional analysis, will be presented. The course is intended for graduate students in Chemical Engineering, Chemistry, Materials Science, and Biomedical Engineering, but advanced undergraduates are welcome.

477. Advanced Numerical Methods: Theory to Implementation
Prerequisites: CHE 116 or BPH 509 or CHM 469 or Equivalent programming and statistics experience and instructor permission.
This is an advanced course where students will learn software engineering, advanced numerical methods, and high performance computing while completing four projects. This course is targeted at students with a programming, engineering and mathematics background who want to use these skills simultaneously to independently solve challenging problems. The theme of the class is going from a set of equations describing a model to a complete implementation. Projects covered include Markov state modeling, Langevin dynamics, classification of protein structures, and multiscale modeling of molecular systems. Students will learn and apply software engineering concepts like unit testing, version control, software containers and high performance computing. Students will learn about advanced numerical methods such as optimizing floating point operations, parallel computing, and GPU computing. (Fall)

480. Chemistry of Advanced Materials
Preparation, structure, composition, and properties of advanced materials with emphasis on the underlying chemistry. Atomic structure and bonding of crystalline and amorphous solids and crystalline defect. Materials synthesis and processing by chemical and physical deposition methods. Focus on the relation of structure to properties of materials. Selected topics to illustrate the basic concepts and principles will include thin film materials, nanostructure/nanoscopic/nanocomposite materials, and bulk materials.

482. Processing Microelectronic Devices
This course features an overview of processes used in the fabrication of microelectronic devices, with emphasis on chemical engineering principles and methods of analysis. Modeling and processing of microelectronic devices. Includes introduction to physics and technology of solid state devices grade silicon, microlithography, thermal processing, chemical vapor deposition, etching and ion implantation and damascene processing. Course is offered August 30 - October 18. (Fall)

485. Thermodynamics & Statistical Mechanics
Introduction to the topic: Thermodynamics and Statistical Mechanics. In the beginning macroscopic thermodynamics including phase equilibria and stability concepts will be covered followed by material related to the principles of statistical mechanics. Applications to various modern areas of the topic will be examined including the Monte Carlo simulation method, critical phenomena and diffusion in disordered media. The course will require completion of a project as well as regular homework assignments. (Spring)
486. Polymer Physics
Prerequisites: University Physics, Organic Chemistry, and Thermodynamics
This course emphasizes the fundamental physics of polymer melts, solutions, networks, and glasses. Topics include: molecular weight and size, chain conformations, thermodynamics of polymer blends and solutions, networks and gelation, polymer dynamics and the glass transition, and morphology and order of semicrystalline polymers. Experimental methods will also be covered including viscometry, size exclusion chromatography, light scattering, scanning calorimetry and dynamic mechanical analysis. Offered odd years. (Spring)

487. Surface Analysis
Graduate and advanced undergraduate course on surface-specific analytical techniques. The first few lectures of the course will cover basic thermodynamics and kinetics of solid-liquid and solid-gas interfaces, including surface energy and tension, surface forces, adsorption and chemisorption, and self-assembly. The rest of the class will focus on surface spectroscopy and microscopy, including X-ray and UV photoelectron spectroscopy, Auger spectroscopy, secondary ion mass spectrometry, IR and Raman spectroscopy/microscopy and scanning probe microscopy. Offered odd years. (Spring)

488. Intro to Energy Systems
The goal of this course is to provide a succinct introduction to the different means of producing energy. The first and second laws of thermodynamics are reviewed to introduce the concepts of conservation of energy and efficiency. Then these concepts are applied to a number of different energy technologies, including wind, hydroelectric, geothermal, fuel cells, biomass, and nuclear. For each type of technology, a technical introduction is given so that the student will understand the governing scientific principles. (Spring)

489. Biosensors
Prerequisite: Graduate level in materials/chemical engineering (or by approval of instructor).
This course aims to introduce students to the highly interdisciplinary field of electrochemical biosensors, and offer insight into the underlying engineering principles. After an overview of fundamental electrochemical principles and biosensors, the course will focus on introducing various designing strategies for electrochemical biosensors, with emphasis on practical applications such as immunoassays, DNA detection and in-vivo neuronal signal monitoring. The students will be exposed to recent publications that highlight key advances in this field. Strong focus will be given to active participation by the students, including literature presentations, critical evaluation of articles, concise technical writing and in-depth discussions. (Spring)

491. Master’s Reading Course Chem

492. Biointerfaces
The course will focus on interfacial phenomena in hybrid bio-inorganic systems. The goal of the course is to increase the understanding of interactions between biomolecules and surfaces. The course will aim at investigating the behavior of complex macromolecular systems at material interfaces and the importance of such systems in the fields of biology, biotechnology, diagnostics, and medicine. The first part of the course will focus on mechanisms of interactions between biomolecules and surfaces. The second part will focus on the characterization of physical, chemical, and morphological properties of biointerfaces. Offered even years.

493. Master’s Essay

494. Masters Internship

495. Master’s Research in Chem En

496. Research Seminar

497. Teaching Chem Engr

507. Advanced Genetics & Genomics
Please see GEN 507. (Fall)

508. Genes, development & Disease

591. Reading Course

594. Internship

595. PhD Research in Chem Engr

595A. PhD Research in Absentia

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Masters Dissertation

897A. Masters Diss in Absentia

897B. Master’s in-Absentia Abroad

899. Master’s Dissertation

899A. Mstrs Dissertatn in Absentia

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence
Computer Science

Professors Allen, Ding, Dwarkadas (Chair), Gildea, Hemaspaandra, Kautz, Luo, Schubert, Scott
Associate Professors Nelson, Stefankovic, Venkitasubramaniam
Assistant Professors Criswell, Hoque, Liu, Pai, Xu, Zhu
Secondary Appointments: Professors Heinzelman, Huang, Jacobs, Sharma; Associate Professors Ipek, Jaeger; Assistant Professors Duan, Ghoshal, Howard

The Department of Computer Science offers a program of study leading to the degrees of Doctor of Philosophy and Master of Science.

PhD Program

The PhD program requires a minimum of 90 graduate-level credits. Only full-time students are admitted to the PhD program, which is designed to require at least four years of study, with the fourth and usually a fifth year devoted to dissertation research and writing. PhD students receive financial support as research assistants (or are fellowship recipients). They are required to serve as teaching assistants for three semesters. PhD students must pass two breadth courses in each of the following three areas: Theory, Systems, and Artificial Intelligence/Human-Computer Interaction. By the end of the third year, each candidate must pass a qualifying examination in the area of thesis research.

MS Program

The master’s program requires a minimum of 30 graduate-level credits. Students may focus on one area of computer science or take courses across the breadth of the field. The degree may be completed on a full-time or part-time basis. For students with an undergraduate degree in computer science or a closely related field, the requirements can usually be completed over the course of three semesters. We welcome applications from students who did not major in computer science but whose undergraduate work demonstrates strong technical skills. MS students must either pass a comprehensive examination or essay (Plan B) or complete a thesis (Plan A). Students completing a thesis must arrange a committee by the end of their first year.

In addition to the courses listed, the department typically offers two or three graduate-level courses in specialized topics that are announced shortly before the start of the semester.
400. Problem Seminar
An introduction to the technical, social, economic, and political aspects of graduate education in computer science at Rochester. Class meetings consist primarily of group discussions and presentations that focus on a broad range of topics, and are intended to improve the critical analysis, technical writing, presentation, and problem-solving skills of students. Both class discussions and written assignments are drawn from material presented in other first-year graduate courses offered within the department. The course also offers a forum for individual department faculty members to discuss their research interests and recent results. Satisfactory performance is required of all first-year graduate students.

404. Multiprocessor Arch

410. Web Programming
The World Wide Web was born around 1990, so it is not much older than most of you. In this course, we will follow the growth of the Web from its toddler years, to early childhood, to its turbulent pre-teen and teenage years, and finally as it begins to mature as a young adult. Along this journey, you will learn influential Web technologies such as HTTP, HTML, JavaScript, CSS, the LAMP stack, XML, JSON, Ajax, WebSockets, and modern MVC frameworks. Even though you will be doing a lot of programming in this course, its purpose is not to teach you to become an expert in any particular language or framework. Web technologies change at a blistering pace, so specifics quickly get outdated. However, once you take this course and understand the fundamentals, you will be able to easily pick up new technologies on the fly.

412. Human Computer Interaction
This course will explore the design, implementation, and evaluation of user interfaces. Students will study the theoretical methods for interface design and evaluation, including requirements gathering, usability heuristics, user interface inspections, usability studies, information visualization, and prototyping. Case studies of interface successes and failures will augment theory with practical experiences. Students will apply this methodology to assignments in the design, implementation, and evaluation cycle. Students taking this course at the graduate level will have additional readings and assignments.

432. Autonomous Mobile Robots

440. Data Mining
Fundamental concepts and techniques of data mining, including data attributes, data visualization, data pre-processing, mining frequent patterns, association and correlation, classification methods, and cluster analysis. Advanced topics include outlier detection, stream mining, and social media data mining. CSC 440, a graduate-level course, requires additional readings and a course project.

442. Artificial Intelligence

443. Topics Computational Neuro
This course is cross-listed with BCS 547. Please refer to that course description.

444. Logical Foundations of A.I.
The logical foundations of AI including first-order logic, reasoning, knowledge representation, planning, and probabilistic inference.

446. Machine Learning
This course presents the mathematical foundations of AI, including probability, decision theory and machine learning.

447. Natural Language Processing
See CSC 447 for description. Cross-listed course.

448. Statistical Speech & Language Processing
An introduction to statistical natural language processing and automatic speech recognition techniques. This course presents the theory and practice behind the recently developed language processing technologies that enable applications such as speech-driven dictation systems, document search engines (e.g., finding web pages) and automatic machine translation. Students taking this course at the 400 level will be required to complete additional readings and/or assignments.

449. Machine Vision
Introduction to computer vision, including camera models, basic image processing, pattern and object recognition, and elements of human vision. Specific topics include geometric issues, statistical models, Hough transforms, color theory, texture, and optic flow. CSC 449, a graduate-level course, requires additional readings and assignments.

450. Data Sci for Linguistics
See LIN250 for course description.

451. Advncd Computer Architecture
This course is cross-listed with ECE201. Please refer to that course description.

452. Computer Organization
Please refer to ECE204

This course explores unique aspects of dynamically-typed programming languages, which are now pervasive in domains such as scientific research, Web application development, gaming, and user interface design. The lessons you will learn here complement those in traditional compilers and programming languages courses, which focus mainly on statically-typed languages. We
will use the Python language as a case study. In the first half of this course, we will study the internals of the Python interpreter, which is implemented in C. In the second half, we will build analysis and debugging tools for Python, potentially extending open-source tools with large user bases.

454. Programming Language Design & Implementation
Design and implementation of programming languages, with an emphasis on imperative languages and on implementation tradeoffs. In-depth examination of “how programming languages work.” Topics include fundamental language concepts (names, values, types, abstraction, control flow); compilation and interpretation (syntactic and semantic analysis, code generation and optimization); major language paradigms (imperative, object-oriented, functional, logic-based, concurrent). Course projects include assignments in several different languages, with an emphasis on compilation issues.

455. Software Performance and Correctness
Programming is the automation of information processing. Program analysis and transformation is the automation of programming itself—how much a program can understand and improve other programs. Because of the diversity and complexity of computer hardware, programmers increasingly depend on automation in compilers and other tools to deliver efficient and reliable software. This course combines fundamental principles and (hands-on) practical applications. Specific topics include data flow and dependence theories; static and dynamic program transformation including parallelization; memory and cache management; type checking and program verification; and performance analysis and modeling. The knowledge and practice will help students to become experts in software performance and correctness. Students taking the graduate level will have additional course requirements and a more difficult project. (Spring)

456. Operating Systems
Principles of operating system design, explored within the practical context of traditional, embedded, distributed, and real-time operating systems. Topics include device management, process management, scheduling, synchronization principles, memory management and virtual memory, file management and remote files, protection and security, fault tolerance, networks, and distributed computing. CSC 456, a graduate-level course, requires additional readings and assignments.

457. Computer Networks

458. Parallel & Dist. Systems
Principles of parallel and distributed systems, and the associated implementation and performance issues. Topics covered will include programming interfaces to parallel and distributed computing, interprocess communication, synchronization, and consistency models, fault tolerance and reliability, distributed process management, distributed file systems, multiprocessor architectures, parallel program optimization, and parallelizing compilers. Students taking this course at the 400 level will be required to complete additional readings and/or assignments.

459. Big Data Computer Systems
Please refer to CSC 459 course description.

460. Dialog Systems
Please refer to CSC 460 for course description.

461. Database Systems
This course presents the fundamental concepts of database design and use. It provides a study of data models, data description languages, and query facilities including relational algebra and SQL, data normalization, transactions and their properties, physical data organization and indexing, security issues and object databases. It also looks at the new trends in databases. The knowledge of the above topics will be applied in the design and implementation of a database application using a target database management system as part of a semester-long group project.

462. Comp Intro to Statistics
Please refer to DSC 462 course description.

463. Comp Models of Music
Please refer to CSC 463 course description.

464. Computer Audition
Please refer to ECE 477 for course description.

465. Intermed Statistical Methods
This course is a continuation of DSC/CSC 462, covering intermediate statistical methodology and related computational methods, with an emphasis on the R statistical computing environment.

466. Intro to Parallel Comp Gpus
Please refer to ECE 206 for course description.

478. Comp. Systems Security

480. Computer Models & Limitations

481. Intro to Cryptography
Please refer to CSC 481 for course description.
482. Design & Analysis Efficient Alg

483. Topics in Cryptography
Please refer to CSC283 for course description.

484. Advanced Algorithms
Advanced study of design and analysis of algorithms. Topics typically include: growth of functions; recurrences; probabilistic analysis and randomized algorithms; maximum flow; sorting networks; expander graphs; matrix operations; linear programming; discrete Fourier transform; number-theoretic algorithms; string matching; computational geometry; NP-completeness; approximation algorithms. Students taking this course at the 400 level may be required to complete additional tests, readings or assignments.

485. Algorithms & Elections
Please refer to CSC285 for course description.

486. Computational Complexity
The difference between computable and uncomputable problems and between feasible and infeasible problems. Regarding the latter, what properties of a problem make it computationally simple? What properties of a problem may preclude its having efficient algorithms? How computationally hard are problems? Complete sets and low information content; P=NP?; unambiguous computation and one-way functions; reductions relating the complexity of problems; complexity classes and hierarchies.

487. Algorithms and Elections
Please refer to CSC285 for course description.

490. Supervised Teaching

491. Independent Study

494. Masters Internship

495. Ms Research in CSC

495A. Masters Research in Absentia

512. Computation Mhtds in Cog Sci
Please refer to BCS512 for course description.

513. Cognitv Processing On Blkbrd
Please refer to BCS 532 for course description.

530. Data-Enabled Research

531. Practicum Data-Enabled

571. Lang Parsing & Complxty

572. Comp. Security Foundations

573. Seminar in Programming Systems
This is a seminar course with varying topics in the area of programming systems. May not be taught every year.

574. Comp Intro to Statistics

575. Seminar in Human Computer Interaction
This is a seminar course on varying topics related to Human Computer Interaction. This course may not be offered every year.

576. Advanced Machine Learning & Optimization

577. Adv. Top. in Comp Vision

578. Deep Lrning & Graph. Models

591. Independent Study

594. Internship

595. PhD Research in CSC

595A. PhD Research in Absentia

595B. PhD Rsrch in Absentia Abroad

597. Computer Science Colloquium

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Masters Dissertation

897A. Masters Dissrttn in Absentia

899. Master’s Dissertation

985. Leave of Absence

986V. Full Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

997A. Doct Dissertatn in Absentia

999. Doctoral Dissertation

999A. Doct Dissertatn in Absentia

999B. In-Absentia Abroad
Electrical and Computer Engineering

Professors Bocko (Chair), Friedman, Heinzelman, Parker, Sharma, Sobolewski
Associate Professors Cetin, Dery, Doyley, Ignjatovic, Ipek, Lin, Mottley, H. Wu
Assistant Professors Anderson, Duan, Howard, Lee, Mateos, S. Wu
Instructor Roessner
Lecturer LaVaque
Secondary Appointments: Professors Dalecki, Donaldson, Dwarkadas, Fienup, Wismueller; Associate Professors Couderc, DeLouise, McAleavy; Assistant Professor Choe

The Department of Electrical and Computer Engineering offers graduate work leading to the MS and PhD degrees. The faculty emphasizes graduate research and instruction in the general areas of electronics and computer systems, optoelectronics, silicon nanoscience, signal/image/audio processing and biomedical imaging, superconductivity and solid state, sensors, networks, electromechanical systems, robotics, and bioinformatics. The faculty serve as directors or key researchers in leading national centers such as the Center for Biomedical Ultrasound, the Center for Emerging and Innovative Sciences, the Robotics and Artificial Intelligence Laboratory, and the Laboratory for Laser Energetics. Outstanding opportunities for graduate student research and training are available at these on-campus centers and in the other departmental laboratories. Research is supervised by members of the faculty and often, though not necessarily, forms the basis for the master's thesis or doctoral dissertation.

Selected examples of current research in several of these areas include digital image and image sequence processing, pattern recognition, medical imaging; fast relaxation processes in semiconductors and in superconductors by use of femtosecond laser pulses; nanoscale silicon for optoelectronics and biosensing; advanced ULSSI and VLSI synchronization and design; analysis and design of computer-based design tools for enhancing productivity of analog and digital circuit designers; semiconductor device modeling; radio frequency integrated circuits, analog to digital converters, image sensors, wireless communications; biomedical instrumentation; protocols for wireless ad hoc networks; sound propagation in tissue with applications to diagnosis, therapy, and surgery; quantum electronic systems; microfluidics; robotics; and audio and music signal processing.

Applicants for graduate study are expected to have performed well in undergraduate programs leading to the BS in electrical and computer engineering or in a related field such as one of the other engineering disciplines or a scientific discipline such as physics, mathematics, or computer science. Students with interests in interdisciplinary work related to electrical and computer engineering usually will find that those interests can be accommodated within the departmental degree requirements.

All graduate students are expected to perform well in their academic coursework. A grade below B– is considered substandard. Two grades below B– may be grounds for dismissal from the graduate program.

**MS Program Requirements**

The MS degree requires 30 hours of graduate courses that must be at the 400-level or higher. There must be at least 16 credit hours in electrical and computer engineering coursework exclusive of research or reading courses.

Every MS degree candidate must declare a concentration of study in one of the research focus areas of our department. Concentrations are organized as three-course sequences. The goal is to provide depth in at least one area, as opposed to a random sampling of courses, with the expectation that students should be able to follow the current research literature in at least one research concentration upon graduation. The areas of concentration are musical acoustics and signal processing; signal/image processing and communications; biomedical/ultrasound; VLSI/IC microelectronics and computer design; superconducting and solid-state electronics; optoelectronics.

Each MS candidate may choose to complete 6 to 12 credit hours of research and write a research thesis (Plan A) or take an MS exam (Plan B), which allows for 0-6 credit hours of research.

**Plan A, Thesis Option**

All thesis students must successfully defend a thesis defense examination. The defense must be conducted by a committee of no less than two ECE faculty members and one outside faculty member.

**Plan B, Exam Option**

All part-time and non-thesis option students must pass an MS exam, which can be a term project, an essay, or an oral exam. The exam must be conducted by a committee of no less than two ECE faculty members. The examination must be completed by mid-December for fall degree conferral or by mid-April for spring conferral.

PhD students who wish to receive an MS degree can satisfy the MS exam requirement by successfully completing the PhD comprehensive examination and submitting an MS Program of Study for 30 credits.

**PhD Program Requirements**

The PhD degree requires 90 credit hours of graduate study (60 credit hours beyond the master's degree), including 16–24 credits of ECE coursework meeting a department requirement of two courses in the chosen concentration area and two other courses outside the student's concentration area. Students are encouraged to begin research early in their programs. The comprehensive examination, taken by the third semester of study once the concentration requirements have been met, is a requirement for continuation in the PhD program.

All doctoral students must pass a PhD qualifying examination and submit a satisfactory written PhD thesis proposal after their third year of full-time graduate study. Students who have passed the PhD qualifying examination are assisted in matters pertaining to their thesis research by a faculty thesis advisory
committee. The research advisor serves as chair. The committee meets with the student at least once each year.

400. Computer Organization
SEE ECE 200 (Spring)

401. Advanced Computer Architecture
Prerequisite: ECE 200 or equivalent.
Instruction set architectures. Advanced pipelining techniques. Instruction level parallelism. Memory hierarchy design. Multiprocessing. Storage systems. Interconnection network (Fall)

402. Memory Systems
Prerequisite: CSC252; ECE201/401 or permission of the instructor
Advanced topics in the organization, architecture, and implementation of modern memory subsystems. Power, performance, reliability, and QoS issues in DRAM memory systems and Flash-based SSDs; high-performance memory controllers and interfaces; memory system design for data centers and enterprise systems. (Fall)

404. Multiprocessor Architecture
Prerequisite: ECE 200
This course provides in-depth discussions of the design and implementation issues of multiprocessor system architecture. Topics include cache coherence, memory consistency, interconnect, their interplay and impact on the design of high-performance micro-architectures. (Spring)

406. GPU Parallel C/C++ Programming
Prerequisites: ECE 200, or ECE 216, or ECE 201/401, or equivalent. Familiarity with assembly language and C programming language. Instructor approval
GPU micro-architecture, including global memory, constant memory, texture memory, SP, SM, scratchpad memory, L1 and L2 cache memory, multi-ported memory, register file, and task scheduler. Parallel programming applications to parallel sorting, reduction, numeric iterations, fundamental graphics operations such as ray tracing. Desktop GPU programming using Nvidia’s CUDA (Compute-Unified Device Architecture), CPU/GPU cooperative scheduling of partially serial/partially parallel tasks. No midterms or written exams. Course consists of seven hands-on projects using CUDA.

409. Machine Learning
Prerequisites: CSC 242 and MTH 165
This course presents the mathematical foundations of AI, including probability, decision theory and machine learning. (Spring)

423. Semiconductor Devices
Prerequisite: Instructor approval
Modern solid state devices, their physics and principles of operation. Solid state physics fundamentals, free electrons, band theory; transport properties of semiconductors, tunneling. Semiconductor junctions and transistors. Compound and semimagnetic semiconductors. Optoelectronic and ultrafast devices. (Fall)

424. Intro Condensed Matter Phy
Prerequisites: PHY 217, 227, 237
An emphasis on the wide variety of phenomena that form the basis for modern solid state devices. Topics include crystals; lattice vibrations; quantum mechanics of electrons in solids; energy band structure; semiconductors; superconductors; dielectrics; and magnets (Spring)

426. Integrated Photonics
See OPT 468 (Fall)

428. Radiation & Detectors
See OPT 425

429. Audio Electronics
Prerequisite: ECE 221 or Permission of Instructor
The devices, circuits, and techniques of audio electronics are covered in this course. Included is a survey of small signal amplifier designs and small-signal analysis and characterization, operational amplifiers and audio applications of opamps, large-signal design and analysis methods including an overview of linear and switching power amplifiers. The course also covers the design of vacuum tube circuits, nonlinearity and distortion. Other important audio devices are also covered including microphones, loudspeakers, analog to digital and digital to analog converters, and low-noise audio equipment design principles. (Spring)

432. Acoustical Waves
Prerequisites: MTH 164 and PHY 121
Acoustic wave equation; plane, spherical, and cylindrical wave propagation; reflection and transmission at boundaries; normal modes; absorption and dispersion; radiation from points, spheres, cylinders, pistons, and arrays; diffraction; nonlinear acoustics. (Summer)

433. Musical Acoustics
Prerequisites: Linear algebra and Differential Equations (MTH 165), Multivariable Calculus (MTH 164), and Physics (PHY 121) or equivalents
Aspects of acoustics. Review of oscillators, vibratory motion, the acoustic wave equation, reflection, transmission and absorption of sound, radiation and diffraction of acoustic waves. Resonators, hearing and speech, architectural and environmental acoustics. (Fall)
435. Introduction to Optoelectronics
Prerequisites: ECE230 and ECE221 equivalent or permission of instructor.
Introduction to fundamentals of wave propagation in materials, waveguides and fibers, generation, modulation and detection of light using semiconductor devices, and elements of optoelectronic systems. (Spring)

436. Nanophotonic and Nanomechanical Devices
Prerequisites: ECE 230 or 235/435; OPT 262 or 462, or 468, or 223, or 412; PHY 237, or 407
Various types of typical nanophotonic structures and nanomechanical structures, fundamental optical and mechanical properties: micro/nano-resonators, photonic crystals, plasmonic structures, metamaterials, nano-optomechanical structures. Cavity nonlinear optics, cavity quantum optics, and cavity optomechanics. Fundamental physics and applications, state-of-art devices and current research trends. This class is designed primarily for graduate students. It may be suitable for senior undergraduates if they have required basic knowledge. (Fall)

437. Autonomous Mobile Robots

440. Introduction to Random Processes
Prerequisite: ECE242 or equivalent
The goal of this course is to learn how to model, analyze and simulate stochastic systems, found at the core of a number of disciplines in engineering, for example communication systems, stock options pricing and machine learning. This course is divided into five thematic blocks: Introduction, Probability review, Markov chains, Continuous-time Markov chains, and Gaussian, Markov and stationary random processes. (Fall)

441. Detection & Estimation Theory
Prerequisites: ECE440or equivalent, or permission of instructor.
Loss and utility; Bayesian inference; risk functions, randomized decisions, admissible decisions; empirical Bayes for unknown prior; Neyman-Pearson hypothesis testing, receiver operating characteristic; sufficient and minimal sufficient statistics and Rao-Blackwellization; unbiased estimation; minimum variance unbiased estimation and Cramer-Rao inequality, maximum likelihood estimation; nonparametric estimation of cdfs. (Spring)

442. Network Science Analytics
Prerequisites: Some mathematical maturity, comfortable with linear algebra, probability, and analysis (e.g., MTH164-165). Exposure to programming and Matlab useful, but not required.
The science of networks is an emerging discipline of great importance that combines graph theory, probability and statistics, and facets of engineering and the social sciences. This course will provide students with the mathematical tools and computational training to understand large-scale networks in the current era of Big Data. It will introduce basic network models and structural descriptors, network dynamics and prediction of processes evolving on graphs, modern algorithms for topology inference, community and anomaly detection, as well as fundamentals of social network analysis. All concepts and theories will be illustrated with numerous applications and case studies from technological, social, biological, and information networks. (Spring)

443. Probabilistic Models for Inference and Estimation
Prerequisite: ECE 270
Probability and stochastic processes, IID and Markov processes, basics of inference and estimation, MAP and ML estimates, modeling with latent variables, expectation maximization, hidden Markov Models, stochastic context free grammars, Markov and conditional random fields, energy models. Select applications in computer vision, machine learning, image processing, communications, and bioinformatics. (Fall)

444. Digital Communications
Prerequisites: ECE 242 and ECE 440 or permission of Instructor
Digital communication system elements, characterization and representation of communication signals and systems. Digital transmission, binary and M-ary modulation schemes, demodulation and detection, coherent and incoherent demodulators, error performance. Channel capacity, mutual information, simple discrete channels and the AWGN channel. Basics of channel coding and error correction codes. (Fall)

445. Wireless Communications
Prerequisites: Undergraduate course in communications (e.g., ECE 242) or instructor permission
This course teaches the underlying concepts behind traditional cellular radio and wireless data networks as well as design trade-offs among RF bandwidth, transmitter and receiver power and cost, and system performance. Topics include channel modeling, digital modulation, channel coding, network architectures, medium access control, routing, cellular networks, WiFi/IEEE 802.11 networks, mobile ad hoc networks, sensor networks and smart grids. Issues such as quality of service (QoS), energy conservation, reliability and mobility management are discussed. Students are required to complete a semester-long research project in order to obtain in-depth experience with a specific area of wireless communication and networking. (Spring)

446. Digital Signal Processing
Prerequisites: ECE 241 and matlab programming skills
Analysis and design of discrete-time signals and systems, including: difference equations, discrete-time filtering, z-transforms, A/D and D/A conversions, multi-rate signal processing, FIR and IIR filter design, the Discrete Fourier Transform (DFT), circular convolution, Fast Fourier Transform (FFT) algorithms, windowing, and classical spectral analysis. (Fall)

447. Digital Image Processing
Prerequisites: ECE242 and ECE440 & 446 are recommended or permission of instructor
This course will introduce the students to the basic concepts of digital image processing, and establish a good foundation for
further study and research in this field. The theoretical components of this course will be presented at a level that seniors and first year graduate students who have taken introductory courses in vectors, matrices, probability, statistics, linear systems, and computer programming should be comfortable with. Topics covered in this course will include intensity transformation and spatial filtering, filtering in the frequency domain, image restoration, morphological image processing, image segmentation, image registration, and image compression. The course will also provide a brief introduction to Python (ipython), the primary programming language that will be used for solving problems in class as well as take-home assignments. (Fall)

448. Wireless Sensor Networks
This course will cover the latest research in the area of Wireless Sensor Networks. We will cover all aspects of these unique and important systems, from the hardware and radio architecture through protocols and software to applications. Topics will include sensor network architectures, hardware platforms, physical layer techniques, medium access control, routing, topology control, quality of service (QoS) management, localization, time synchronization, security, storage, and other advanced topics. Each student must complete a semester-long course related to wireless sensor networks. (Spring)

449. Machine Vision
Prerequisites: MTH 161 and CSC 242
Fundamentals of computer vision, including image formation, elements of human vision, low-level image processing, and pattern recognition techniques. Advanced topics include modern visual features, graphical models, model-based and data-driven approaches, and contextual inference, as well as examples of successes and challenges in applications. CSC 449, a graduate-level course, requires additional readings and assignments (including a course project). (Spring)

450. Information Theory
Prerequisites: MTH 201, or permission of instructor
Entropy, Relative Entropy, mutual information, asymptotic equipartition property, data compression, channel capacity, joint source channel coding theorem, Gaussian channels, rate distortion theory, selected applications. (Spring)

451. Biomedical Ultrasound
SEE BME 253 (Spring)

452. Medical Imaging-Theory & Implementation
Prerequisite: ECE 242
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Fourier transform relations and reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI. (Fall)

453. Ultrasound Imaging
Introduction to the principles and implementation of diagnostic ultrasound imaging. Topics include linear wave propagation and reflection, fields from pistons and arrays, beamforming, B-mode image formation, Doppler, and elastography. Project and final report (Spring)

455. Software Analysis & Improvement
Prerequisite: CSC 254; CSC 252 recommended
Programming is the automation of information processing. Program analysis and transformation is the automation of programming itself—how much a program can understand and improve other programs. Because of the diversity and complexity of computer hardware, programmers increasingly depend on automation in compilers and other tools to deliver efficient and reliable software. This course combines fundamental principles and (hands-on) practical applications. Specific topics include data flow and dependence theories; static and dynamic program transformation including parallelization; memory and cache management; type checking and program verification; and performance analysis and modeling. The knowledge and practice will help students to become experts in software performance and correctness. Students taking the graduate level will have additional course requirements and a more difficult project. (Spring)

457. Digital Video Processing
Prerequisite: ECE 446 (Digital Signal Processing)
Basics of digital video, digital video filtering, and video-based object recognition and tracking. Core topics to include: algorithms for 2-D motion estimation, compression, video segmentation, image enhancement, transform and sub-band/wavelet coding, compression, feature extraction from video, and 3-D video processing. Projects will apply video-based techniques for solving a wide variety of problems in areas such as person and object tracking, human motion analysis, biometrics, and scene understanding. (Spring)

461. Introduction to VLSI
Prerequisites: ECE 112 and ECE 221
Introduction to high performance integrated circuit design. Semiconductor technologies. CMOS inverter. General background on CMOS circuits, ranging from the inverter to more complex logical and sequential circuits. The focus is to provide background and insight into some of the most active high performance related issues in the field of high performance integrated circuit design methodologies, such as CMOS delay and modeling, timing and signal delay analysis, low power CMOS design and analysis, optimal transistor sizing and buffer tapering, pipelining and register allocation, synchronization and clock distribution, retiming, interconnect delay, dynamic CMOS design techniques, power delivery, on-chip regulators, 3-D technology and circuit design, asynchronous vs. synchronous tradeoffs, clock distribution networks, low power design, and CMOS power dissipation. (Fall)
462. Advanced Cmos VLSI Design  
Prerequisite: ECE261 or ECE222  
Senior design course for "Computer Design" or "Integrated Electronics" concentrations. Review of CMOS Subsystem design. Design focus on digital or mixed-signal systems, such as a simple microprocessor, a self-timed multiplier, a digital filter, data converter, or memory. Project design requirements include architectural design, logic and timing verification, layout design, and test pattern generation. Extensive use of CAD tools. The resulting VLSI chips may be fabricated. (Spring)

466. Rf and Microwave Integrated Circuits  
Prerequisites: ECE222, ECE230 or equivalent. Permission of Instructor  
This course involves the analysis and design of radio-frequency (RF) and microwave integrated circuits at the transistor level. We begin with a review of electromagnetics and transmission line theory. Several design concepts and techniques are then introduced, including Smith chart, s-parameters, and EM simulation. After the discussion of RLC circuits, high-frequency narrow-band amplifiers are studied, followed by broadband amplifiers. Then we examine the important issue of noise with the design example of low-noise amplifiers (LNA). Nonlinear circuits are studied next with the examples of mixers. A study of oscillators and phase noise follows. Afterwards we introduce phase-locked loops (PLL) and frequency synthesizers. The course concludes with an overview of transceivers architectures. The course emphasizes the development of both circuit design intuition and analytical skills. There are bi-weekly design labs and a term project using industry-standard EDA tools (ADS, Asic, etc.). (Spring)

467. Analog Integrated Circuit  
Prerequisites: ECE113, ECE221  
MOSFET and bipolar device structures and models. Analysis and design of analog CMOS integrated circuits. Modern opamp design with noise, offset and distortion analysis, feedback, frequency compensation, and stability. Current mirrors and bandgap references. Sampling devices and structures. More advanced design projects and use of design aids and CAD tools (including simulation and synthesis) are included.

468. Advanced Analog Cmos Circuits and Systems  
Prerequisites: ECE113, ECE221, ECE222, ECE246/446, ECE 467  
Circuitry, algorithms, and architectures used in analog and mixed-mode CMOS integrated circuits. Switched-capacitor (SC) elements, amplifier stages, and filters. Other SC circuits: S/H stages, comparators, PGAs, oscillators, modulators, voltage boosters, and dividers, Non-ideal effects in SC circuits, and correction techniques. Low-voltage SC design. Nyquist-rate data converter fundamentals; SC implementations of DACs and ADCs. Oversampling (delta-sigma) data converters: fundamentals and implementations. (Spring)

469. High Speed Integrated Electronics  
Prerequisites: ECE222 and ECE230  
We begin with an overview of high speed semiconductor technologies (CMOS, SiGe, SOI, GaAs, InP, etc) and devices (MOSFET, MESFET, HEMT, HBT, and tunneling diodes), followed by discussion of device characterization and technology optimization for circuit performance. We focus on the design of wideband and high power amplifiers, which includes discussions on feedback, impedance matching, distributed amplifiers, power combining, and switching power amplifiers. The third part of the course involves the design of high speed phase locked and delay-locked loops (PLL and DLL). After a review of PLL basics, we discuss its building blocks: VCO, frequency divider, phase detector, and loop filter. We also analyze its performance, in particular phase noise, jitter, and dynamic performance, and how to improve them. Two important applications, frequency synthesis and clock recovery, serve as the examples in our discussion. Each part of the course also includes related simulation methods and measurement techniques.

471. Comp Models of Music Processes  
Fundamentals of computational music including selected topics in modern music theory and music representation, encoding of music information by computers, musical sound representation and compression, automated music transcription, human-computer music interfaces and music informatics. (Spring)

472. Audio Signal Processing  
Prerequisites: ECE 114 and basic Matlab programming, ECE 241 or other equivalent signals and systems courses.  
This course is a survey of audio digital signal processing fundamentals and applications. Topics include sampling and quantization, analog to digital converters, time and frequency domains, spectral analysis, vocoding, digital filters, audio effects, music audio analysis and synthesis, and other advanced topics in audio signal processing. Implementation of algorithms using Matlab and on dedicated DSP platforms is emphasized. (Spring)

473. Computational Models of Music  
We will explore various computational approaches to musical problems (rule-based approaches, connectionism, dynamic systems, and probabilistic models), focusing on two main areas: 1) models of musical processing and information retrieval; 2) models of musical styles. Our focus will be on the symbolic level of music representation rather than on the signal level (there will be no signal processing in this course). Most assignments will consist of reading articles and answering questions about them. There will be some programming assignments, with other options for students without programming ability. (Spring)

474. Biomed Sensors, circuits & Intr  
Prerequisites: BME210, EC 113 or equivalent, or permission of Instructor  
Circuits and sensors used to measure physiological systems at an advanced level. Measurement of strain, pressure, flow, temperature, biopotentials, and physical circuit construction.
475. Audio Software Design
Prerequisite: ECE114 or instructor permission

In this course, students will develop the ability to design programs in C, Python, Max, and Pure Data for audio/music research, computer music, and interactive performance. We will begin with an introduction to computer music and audio programming. After a quick review of C, we will use the PortSF library to generate and process basic envelopes and waveforms, and to explore the development of the table-lookup oscillator and other DSP tools. Max and Pure Data are similar visual programming languages for music and multimedia. We will use Max to explore topics in sound synthesis, signal processing, and sound analysis, as well as computer music. Python is a general-purpose programming language used in many application domains. We will use JythonMusic, a special version of Python, for music making, building graphical user interfaces, and for connecting external human interface devices. Students will practice their programming techniques through a series of programming assignments and a final project. (Fall)

476. Audio Software Design II
Prerequisites: AME 262, ECE 475 or instructor permission

This course is a sequel to AME 262, ECE 475/TEE 475 Audio Software Design I. The first part of the course will explore designing audio plug-ins with Faust (Function AUdio ST ream), which is a high-level functional programming language designed for real-time audio digital signal processing (DSP) and sound synthesis. Students will learn how to design plug-ins for Pro Tools, Logic and other digital audio workstations (DAWs). The second part of the course will focus on audio programming for iOS apps in Swift, which is the new programming language for iOS and OS X. Students will learn how to make musical apps with the sound engine libpd, which turns Pure Data (Pd) into an embeddable library. A special topic will introduce audio programming for video games with Wwise and FMOD. (Spring)

477. Computer Audition
Prerequisites: ECE 246/2446 or ECE 272/472 or other equivalent signal processing courses, and Matlab programming. Knowledge of machine learning techniques such as Markov models, support vector machines is also helpful, but not required.

Computer audition is the study of how to design a computational system that can analyze and process auditory scenes. Problems in this field include source separation (splitting audio mixtures into individual source tracks), pitch estimation (estimating the pitches played by each instrument), streaming (finding which sounds belong to a single event/source), source localization (finding where the sound comes from) and source identification (labeling a sound source). (Fall)

478. Revolutions in Sound: Artistic and Technical Evolution of Sound Recording

This course will provide a multifaceted account of the evolution of sound technologies, starting with Edison’s invention of the phonograph in 1877 through the development of microphones, radio, magnetic tape recording, vinyl records, multitrack recording, digital audio, compact discs, the MP3 format, and online music streaming. We will discuss how technology has shaped the musical experience, and, conversely, how the performance of various genres of music, including classical, rock, jazz, hip-hop, and country, has influenced the development of audio technologies. We will also investigate, drawing from a variety of primary and secondary sources, how certain legendary recordings were produced, including those of Enrico Caruso, Bessie Smith, Les Paul, Louis Armstrong, Elvis Presley, The Beatles, Michael Jackson, and Madonna. A special topic will focus on the digital preservation and restoration of historic audio recordings. (Spring)

479. Audio Recording - Technology and Fundamentals
Prerequisite: Instructor’s permission required

This course covers the acoustical and psychoacoustic fundamentals of audio recording including the nature of sound, sound pressure level, frequency and pitch, hearing and sound perception, reflection, absorption and diffusion of sound, sound diffraction, room acoustics, reverberation, and studio design principles. The course also provides practical experience in audio recording including an introduction to recording studio equipment, microphones and microphone placement techniques, signal flow, amplification, analog and digital recording, analog to digital conversion, digital processing of sound, multi-track recording and an introduction to mixing and mastering. Each student is required to complete a substantive recording project at the end of the course. (Fall Spring)

491. Master’s Reading Course ECE

492. Special Topics: Future Electronic Devices From Condensed Matter Physics Topics
Prerequisites: Basic Undergraduate Math and Physics

Course will cover basic topics in semiconductor device physics, electronic band structure, materials science, and magnetism with a focus on applications to new and emerging electronic device technologies. Base level knowledge will be provided to both understand existing devices and design improvements using new physics and materials. This background will serve as a jumping off point to discuss potential future electronic devices with novel properties beyond the current status quo. Topics covered: 2D electronic materials/devices, magnetic memory, spintronics, multiferroic memory, topological matter/devices. (Spring)

493. Master’s Essay

494. Research Internship

495. Master’s Research in ECE

495A. Masters Research in Absentia

496. Special Projects in ECE
520. Spin Based Electronics
Prerequisite: Permission of Instructor & familiarity with elementary quantum mechanics

Up until now CMOS scaling has given us a remarkable ride with little concern for fundamental limits. It has scaled multiple generations in feature size and in speed while keeping the same power densities. However, CMOS finally encounters fundamental limits. The course is intended for students interested in research frontiers of future electronics technologies. The course begins with introduction to the basic physics of magnetism and of quantum mechanical spin. Then it covers aspects of spin transport with emphasis on spin-diffusion in semiconductors. The second part of the course is comprised of student and lecturer presentations of selected spintronics topics which may include: spin transistors, magnetic random access memories, spin-based logic paradigms, spin-based lasers and light emitting diodes, magnetic semiconductors, spin-torque devices for memory applications and the spin Hall effect. (Spring)

591. PhD Reading Course in ECE
592. Acoustic Imaging II
594. PhD Research Internship
594P. PhD Research Internship PT
595. PhD Research in ECE
595A. PhD Research in Absentia
597. ECE Colloquium
890. Summer in Residence - MA
895. Cont of Master’s Enrollment
897. Master’s Dissertation
897A. Master’s Diss in Absentia
897B. Master’s in Absentia
899. Master’s Dissertation
899A. Master’s Dissertation
899B. Master’s in-Absentia Abroad
985. Leave of Absence
986V. Full-Time Visiting Student
987V. Part Time Visiting Student
990. Summer in Residence
995. Cont of Doctoral Enrollment
997. Doctoral Dissertation
997A. Doct Dissertatn in Absentia
999. Doctoral Dissertation
999A. Doct Dissertatn in Absentia
Engineering and Applied Sciences

448. Wireless Sensor Networks

499. Degree Complete Status

Materials Science

Professors Anthamatten, Awad, Bigelow, Bocko, Boyd, Burns, Chen, Chimowitz, Dewhurst, Donaldson, Funkenbusch, Y. Gao, C. Guo, Jorné, Krauss, Knox, Lampropoulos, McGrath, B. L. Miller, Rolland, Rothberg (Chair), Sobolewski, Waugh, Wicks, Wu, M. Z. Yates
Associate Professors Benoit, DeLouise, Dery, Grossfield, C. K. Ku, Nilsson, Shestopalov, Vamivakas
Assistant Professors Abdolrahim, Askari, Franco, P. Huo, D. Kelley, Knowles, Tenhaeff, A. White, S. Wu

Materials science deals with the creation, understanding, and use of novel materials for advanced technologies. Specifically, synthesis and processing are used to create the molecular, supramolecular, nanoscale, and microscopic structures required to achieve desired properties. Understanding of new materials is acquired through theoretical or computational approaches to the interpretation of experimentally determined properties at all length scales. Historically, new materials are the cornerstones of technological advances. Today, advanced materials, i.e., high-value-added materials engineered for specialized applications, constitute one of the technology areas of national and international prominence. Intensive efforts are under way worldwide to develop improved and new materials for a diversity of technologies. To tackle problems of this dimension, materials science has evolved into an interdisciplinary research enterprise cutting across traditional boundaries among chemical, electrical, and mechanical engineering, chemistry, optics, and physics. The University of Rochester’s tradition and infrastructure are uniquely suited for nurturing cutting-edge materials research targeting imaging, information, biomedical, and energy technologies.

The Materials Science Program offers MS and PhD degrees. The program draws students from a wide range of educational background: biological, chemical, electrical, and mechanical engineering, materials science, ceramics, chemistry, physics, and optics. It is strongly recommended that applicants take the GRE. The TOEFL or IELTS is generally required of foreign students. Students interested in obtaining materials science degrees are required to design a program of study consisting of a balance between coursework and research in consultation with thesis advisors associated with one of the participating academic departments.

In the Departments of Biomedical Engineering and Chemical Engineering, a materials science student works on the synthesis, processing, and molecular simulation of advanced materials for aerospace, biomedical, information, energy, and environmental applications. Biomaterials are designed with distinct capabilities, such as controlling cell behavior or overcoming drug delivery barriers. Modern facilities are available for cell and tissue engineering; recombinant DNA and molecular biology; inorganic materials for membrane separation, fuel storage, and gas sensor technology; synthesis, processing, and simulation of functional polymers and molecular materials new fuel cell materials and optimization; device science and engineering for electronics, optics, photonics, and optoelectronics; electrical engineering applied to microelectronics, energy conversion, and
storage; reaction, transport, and phase transition in porous media; organic light-emitting diodes and interfacial phenomena in multiphase systems.

In the Department of Mechanical Engineering, a student working in materials science concentrates on the relation between microstructure and mechanical properties of metals, ceramics, glasses, and polymers. Current projects include nanostructures catalysis for fuel cell applications, scratching of polymer films, design of ecologically friendly nanostructured solders, impression creep and recovery, microgrinding and polishing of glass and crystalline materials, powder processing, deformation of ionic materials, residual stress measurements, failure and adhesion analysis, piezoelectric materials, corrosion and the design of fracture-tough materials. The College maintains specialized equipment including electron microscopes, an energy-dispersive X-ray microprobe, several Instron tensile testers, MTS and Instron servo-controlled fatigue machines, nanoindenters, a differential scanning calorimeter, a hot isostatic press, melt-spin apparatus, and state-of-the-art X-ray diffraction equipment.

In the Department of Electrical and Computer Engineering, a materials science student may enter such research areas as the electronic effects of surface preparation in semiconductors and insulators, silicon nanostructures, porous silicon and optoelectronic applications, bulk diffusion effects in semiconductors, ultrafast electronics, and high-temperature superconductors in thin films. Current projects include superconducting and magnetic thin films, microwaves, MEMS, picosecond phenomena, and fluctuations in superconductors.

In The Institute of Optics, a materials science student concentrates on the properties of materials important to optical applications, including nanophotonics. Many topics in the broad areas of optical materials and photonics are appropriate, such as the following: the interaction of light and materials to create new optical effects, interaction of intense laser radiation and matter, new crystals and glasses for manipulating light from the deep UV to the IR, and new technologies for precision manufacture and testing of novel optics. Some examples of current or previously explored subjects include the tribomechanical basis for polishing of optical glasses, improved photonic crystals for fiber laser amplifiers, and characterization of solid-state diffusion in optical index gradient materials.

In the Department of Chemistry, a materials science student can participate in research on making and understanding novel devices based on organic and biological materials. Applications include electroluminescent displays, photovoltaic cells, and biomolecular sensors. Studies vary from the physics of charge transport in organic semiconductors, to the mechanism for current photogeneration, to devising new fabrication and patterning methods that take advantage of the processability of organic materials.

In the Department of Physics, a materials science student can work on the theoretical and/or experimental aspects of condensed-matter physics. Current projects include universality of interfacial fluctuations and cyclic growth; large-scale Monte Carlo simulations of vertex line dynamics in high-Tc superconductors; transport and tunneling phenomena in ultrathin metal films; and interfaces in organic semiconductors and ultrafast dynamics in solids.

A materials science student in the Department of Earth and Environmental Sciences has access to state-of-the-art thermal ionization and inductively coupled plasma source mass spectrometers that are used to determine the trace metal content and isotopic composition of geological, environmental, and biological materials. Research topics include the fate and behavior of carbon nanotubes and fullerenes in nature, mineralogy, crystallography and the study of optical properties of silicates, carbonates, phosphates, and oxides in polarizing light microscopy.

Materials science students may also choose to do research in the School of Medicine and Dentistry in the Departments of Dermatology, Microbiology and Immunology, or Biochemistry and Biophysics. Research topics range from optical biosensing and nanoparticle skin toxicity imaging to computational studies on the molecular-level properties of lipid membranes and the proteins and other molecules that bind to them. The study of nanoparticle-based vaccines delivered under the tongue, or “sublingually,” can be an effective new materials approach to preventing HIV transmission.

**PhD Program**

A typical program for a materials science (MSC) PhD student entering with a BS degree consists of a minimum of 24 credit hours of MSC graduate courses, exclusive of reading courses, 8 credit hours of other related courses, and 38 credit hours of research. A typical program for an MSC PhD student entering with an MS degree consists of a minimum of 24 credit hours of MSC graduate courses plus 36 credit hours of research. Students must successfully complete an oral defense of their theses.

**MS Program**

The MS degree in materials science requires a minimum of 30 credit hours of graduate courses. There are two paths to obtaining an MS: Plan A, with thesis; and Plan B, without thesis. Plan B is the normal, default option for entering students. If students wish to pursue a Plan A path instead, it is the students’ responsibility to make arrangements with a faculty thesis advisor to supervise their work and to inform the MSC program office of this.

For students electing to obtain the MS degree with thesis (Plan A), the following requirements apply: The 30 credit hours must include a minimum of 20 credit hours of MSC graduate courses plus 10 credit hours for research, and students must successfully complete an oral defense of their theses, after all other degree requirements have been completed.

For students electing to obtain the MS degree without a thesis (Plan B), the following requirements apply: The 30 credit hours must include a minimum of 24 credit hours of MSC graduate courses plus 6 credit hours of other related courses. The maximum number of research credits for a Plan B MS degree is 6 credit hours. A student in Plan B must pass a comprehensive oral examination.

It is assumed that all incoming students have completed a basic undergraduate course in materials. If not, students must complete MSC 480, Introduction to Materials Science. All first-year graduate students are required to register for the Materials Science Graduate Seminar Series (MSC 496).
401. Phase Transformation
How and why atomic rearrangements leading to phase transformations occur and how they are associated with kinetic and crystallographic features; liquid-solid and solid-solid transformations, nucleation theory, growth, massive and martensitic transformations. (Fall)

403. Characterization Methods in Materials Science - Diffraction
Crystallography, symmetry elements, space groups, x-ray diffraction from single crystals and powder patterns. Fourier transforms, grain size effects, residual stresses and textures, diffuse and small angle scattering, Bragg and Laue x-ray diffraction topography, thin films and epitaxial layers. Modern x-ray software for diffraction analysis including textures, residual stresses, pattern identification and Rietveld applications. (Fall)

404. Biophysical Chemistry II
This course explores how fundamental interactions determine the structure, dynamics, and reactivity of proteins and nucleic acids. Examples are taken from the current literature with emphasis on thermodynamic, kinetic, theoretical, and site-directed mutagenesis studies. Paper and presentation. (Spring - odd years).

405. Thermodynamics of Solids
Review of basic thermodynamic quantities and laws; equations of state; statistical mechanics; heat capacity; relations between physical properties; Jacobian algebra; phase transformations, phase diagrams and chemical reactions; partial molar and excess quantities, phases of variable composition; free energy of binary and multicomponent systems; surfaces and interfaces. The emphasis is on the physical and chemical properties of solids including stress and strain variables. (Spring)

406. Fracture & Adhesion
Prerequisites: ME 280, 226
Stress fields near cracks in linear elasticity. Linear elastic fracture mechanics. Griffith fracture theory. K and J approaches to fracture. Failure analysis and fracture stability; crack tip deformation, crack tip shielding. Crack nucleation. Adhesion. Low cycle fatigue; fatigue crack propagation. Emphasis on the role of microstructure in determining fracture, adhesion and fatigue behavior of materials; improving fracture toughness for advanced materials especially ceramics and polymers. This course is taught at a level that brings the student to the level of current research. (Fall)

407. Solids & Materials Lab
Prerequisites: ME280, ME226, MTH161, 162 and CHM 131
In this course, you will apply previously learned theoretical concepts to practical problems and applications. In addition, you will learn experimental techniques and enhance your technical writing skills. This course has two parts, a series of small laboratory exercises and a project. During the semester, students will work in groups of three to complete the assigned work, labs, and reports. The lab section of the course is designed to present basic applied concepts that will be useful to a broad base of engineering problems. The project portion is where you will work on a more specific idea, tailored around your desired future goals. (Fall)

409. Mechanical Behavior of Solids
Prerequisites: ME 280, MTH 163 or equivalent
The mechanical response of crystalline (metals, ceramics, semiconductors) and amorphous solids (glasses, polymers) and their composites in terms of the relationships between stress, strain, damage, fracture, strain-rate, temperature, and microstructure. Topics include: (1) Material structure and property overview. (2) Isotropic and anisotropic elasticity and viscoelasticity. (3) Properties of composites. (4) Plasticity. (5) Point and line defects. (6) Interfacial and volumetric defects. (7) Yield surfaces and flow rules in plasticity of polycrystals and single crystals. (8) Macro and micro aspects of fractures in metals, ceramics and polymers. (9) Creep and superplasticity. (10) Deformation and fracture mechanism maps. (11) Fatigue damage and failure; fracture and failure in composites (If time permits). (Fall)

413. Engineering of Soft Matter
This course will provide an overview of several contemporary research topics pertaining to structured organic materials. Lectures will focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures will introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials. Homework assignments and a brief technical presentation will be required. (Spring)

416. X-Ray Crystallography
Prerequisites: CHM 211, 411, or 415; some understanding of symmetry operations is expected
2 credit hour course- Students will learn the basic principles of x-ray diffraction, symmetry, and space groups. Students will also experience the single crystal diffraction experiment, which includes crystal mounting, data collection, structure solution and refinement, and the reporting of crystallographic data. Weekly assignments: problem sets, simple lab work, or computer work. (Spring, 2nd half of semester.)
418. **Statistical Mechanics**  
*Prerequisites: PHY 227 or equivalent; PHY 407, PHY 408 concurrently*  
Review of thermodynamics; general principles of statistical mechanics; micro-canonical, canonical, and grand canonical ensembles; ideal quantum gases; applications to magnetic phenomena, heat capacities, black-body radiation; introduction to phase transitions. (Spring)

420. **Intro Condensed Matter Phy**  
An emphasis on the wide variety of phenomena that form the basis for modern solid state devices. Topics include crystals; lattice vibrations; quantum mechanics of electrons in solids; energy band structure; semiconductors; superconductors; dielectrics; and magnets. (Fall)

421. **Biomedical Nanotech**  
This course is designed to provide students with detailed knowledge of the principles of nanotechnology and their applications in the biomedical field. Topics of study will include synthesis & assembly of nanoscale structures, lithography, and nanobiomaterials. Students will focus on biomedically-relevant topics such as cancer treatment, bone disorder, diabetes; and learn how nanotechnology is helping diagnose, treat, and understand these medical disorders. Recent innovative research in the biomedical field will be highlighted during discussions of the latest journal articles. At the end of the course, students will have an appreciation of the enormous potential of biomedical nanotechnology, its current, and future applications. (Fall)

423. **Semiconductor Devices**  

424. **Robust Design and Quality**  
Definition and pursuit of “quality” as a design criterion. The concept of robust design. Selection of the quality characteristic, incorporation of noise, and experimental design to improve robustness. Analysis and interpretation of results. (Fall)

432. **Opto-Mechanical**  
The mechanical design and analysis of optical components and systems will be studied. Topics will include kinematic mounting of optical elements, the analysis of adhesive bonds, and the influence of environmental effects such as gravity, temperature, and vibration on the performance of optical systems. Additional topics include analysis of adaptive optics, the design of lightweight mirrors, thermo-optic and stress-optic (stress birefringence) effects. Emphasis will be placed on integrated analysis which includes the data transfer between optical design codes and mechanical FEA codes. A term project is required for MSC 432. (Spring)

436. **Molecular Spectroscopy & Str**  
This 2 credit course covers the basic theory and experimental practice of spectroscopy in molecules and condensed matter. A general review of electromagnetic waves is followed by time dependent perturbation theory and a density matrix treatment of two-level systems. The basic principles are applied electronic, vibrational and rotational spectroscopy. The course draws heavily on literature studies that exemplify the material. (same as CHM 458)

437. **Nanophotonic and Nanomechanical Devices**  
*Prerequisites: ECE 230 or 235, OPT 226 or 462, or 468, or 223, or 412; PHY 237, or*  
Various types of typical nanophotonic structures and nanomechanical structures, fundamental optical and mechanical properties: micro/nano-resonators, photonic crystals, plasmonic structures, metamaterials, nano-optomechanical structures. Cavity nonlinearoptics, cavity quantum optics, and cavity optomechanics. Fundamental physics and applications, state-of-art devices and current research trends. This class is designed primarily for graduate students. It may be suitable for senior undergraduates if they have required basic knowledge. (Fall)

442. **Microbiomechanics**  
*Prerequisite: permission of instructor*  
This course covers the application of mechanical principles to biotechnology and to understanding life at its smallest scales. Topics will vary with each course offering. Sample topics include force generation by protein polymerization, the mechanisms of bacterial motion, and the separation of biological molecules in porous media. (Fall)

447. **Liquid-Crystal Materials and Optical Applications**  
This course will introduce the student to the physical, chemical and optical properties of liquid crystals (LC) that are the basis for their wide and successful exploitation as optical materials for a broad variety of applications in optics, photonics and information display. Topics to be presented include: origins of LC physical properties in thermotropic and lyotropic materials as a function of chemical structure, influence of these structure-property relationships on macroscopic organization in LC mesophases, and the effect of molecular ordering and order parameter on properties of special significance for device applications. Operating principles for LC devices in a wide variety of applications will be described, including passive and tunable/switchable polarizers, wave plates, filters, information displays and electronic addressing, electronic paper, color-shifting polarizing pigments, optical modulators, and applications in photonics and lasers. (Fall)

451. **Biomedical Ultrasound**  
*Prerequisites: Math 163, Math 164, Physics 122 or Permission of instructor*  
The course presents the physical basis for the use of high-frequency sound in medicine. Topics include acoustic properties of tissue, sound propagation (both linear and nonlinear) in tissues, interaction of ultrasound with gas bodies (acoustic cavitation
and contrast agents), thermal and non-thermal biological effects of ultrasound, ultrasonography, dosimetry, hyperthermia and lithotripsy.

**454. Interfacial Engineering**  
*Prerequisite: CHE 225*

Lectures on the fundamentals of colloids and interfaces, systems with high interfacial area, and their role in modern processes and products. Topics include interfacial tension, contact angle, adsorption, surfactants, miscelles, microemulsions, and colloidal dispersions. Techniques for formation and characterization of interfaces and colloids will be reviewed.

**455. Thermodynamics & Stat Mech**  
*Prerequisites: One year of physical chemistry (CHM 251 & CHM 252), or equivalent.*

The course draws connections between the orderly and chaotic behavior of simple and complex systems, laying the foundations of statistical equilibrium and equilibrium thermodynamics. The different phases of matter (gases, liquids, solid) assumed by bulk classical interacting particles and their transitions are discussed in this approximation. Properties of non-interacting quantal systems are expressed in terms of partition functions, for gases of simple and complex particles. Non-equilibrium statistical behavior of multi-particle systems leads to diffusion and other transport phenomena. Reading assignments and homework. Two weekly lectures of 75 minutes. (Fall)

**456. Chm Bonds: from Molsc to Mat**  
*Prerequisite: CHM 251 or an equivalent course on introductory quantum mechanics*

An introduction to the electronic structure of extended materials systems from both a chemical bonding and a condensed matter physics perspective. The course will discuss materials of all length scales from individual molecules to macroscopic three-dimensional crystals, but will focus on zero, one, and two dimensional inorganic materials at the nanometer scale. Specific topics include semiconductor nanocrystals, quantum wires, carbon nanotubes, and conjugated polymers. Two weekly lectures of 75 minutes each. (Spring)

**458. Electrochem & Engg & Fuel Cell**

The course will concentrate on presenting the principles of electrochemistry and electrochemical engineering, and the design considerations for the development of fuel cells capable of satisfying the projected performance of an electric car. The course is expected to prepare you for the challenges of energy conversion and storage and the environment in the 21st century.

**460. Solar Cells**

This course will introduce students to the basics of photovoltaic devices: physics of semiconductors; pn junctions; Schottky barriers; processes governing carrier generation, transport and recombination; analysis of solar cell efficiency; crystalline and thin-film solar cells, tandem structures, dye-sensitized and organic solar cells. Students will learn about current photovoltaic technologies including manufacturing processes, and also the economics of solar cells as an alternative energy source. Critical analysis of recent advances and key publications will be a part of the course work.

**462. Cell & Tissue Engineering**  
*Prerequisites: BME 260, CHE225, CHE243, CHE244 or permission of instructor*

This course teaches the principles of modern cell and tissue engineering with a focus on understanding and manipulating the interactions between cells and their environment. After a brief overview of Cell and Tissue Engineering, the course covers 5 areas of the field. These are: 1) Physiology for Tissue Engineering; 2) Bioreactors and Biomolecule Production; 3) Materials for Tissue Engineering; 4) Cell Cultures and Bioreactors and 5) Drug Delivery and Drug Discovery. Within each of these topics the emphasis is on analytical skills and instructors will assume knowledge of chemistry, mass transfer, fluid mechanics, thermodynamics and physiology consistent with the Cell and Tissue Engineering Track in BME. In a term project, students must present written and oral reports on a developing or existing application of Cell and Tissue Engineering. The reports must address the technology behind the application, the clinical need and any ethical implications.

**463. NMR Spectroscopy**  
*Prerequisites: One year of organic chemistry and one semester of physical chemistry (CHM 251) or equivalents*

An introduction to NMR spectroscopy. Collection, processing, and interpretation of homonuclear and heteronuclear 1D and multidimensional spectra will be covered. Topics to be discussed include chemical shifts, relaxation, and exchange phenomena. Examples from organic, inorganic, and biological chemistry will be used. (Fall, 1st half of semester).

**465. Principles of Lasers**

Topics include quantum mechanical treatments to two-level atomic systems, optical gain, homogeneous and inhomogeneous broadening, laser resonators, cavity design, pumping schemes, rate equations, Q-switching for various lasers.

**469. Biotechnology & Bioengineering**

The life science and engineering principles underlying biotechnology processes; established biotechnology processes including microbial and enzyme conversions, metabolic pathways, and fermentation kinetics; tools for biotechnology development including the recombinant DNA and monoclonal antibody techniques; emerging areas at the forefront of biotechnology, including immune technology and tissue and organ cultures.

**470. Opt Properties of Materials**

Interaction of light with materials’ electrons, phonons, plasmons, and polaritons. Optical reflection, refraction, absorption, scattering, Raman scattering (spontaneous and stimulated), light
emission (spontaneous and stimulated). Electrooptic effects and optical nonlinearities in solids. Plasmonics. Semiconductors and their nanostructures are emphasized; metals and insulators also discussed. (Spring)

472. Biointerfaces
The course will focus on interfacial phenomena in hybrid bio-inorganic systems. The goal of the course is to increase the understanding of interactions between biomolecules and surfaces. The course will aim at investigating the behavior of complex macromolecular systems at material interfaces and the importance of such systems in the fields of biology, biotechnology, diagnostics, and medicine. The first part of the course will focus on mechanisms of interactions between biomolecules and surfaces. The second part will focus on the characterization of physical, chemical, and morphological properties of biointerfaces.

473. Intro to Opto-Electronics
Introduction to fundamentals of wave propagation in materials, waveguides and fibers, generation, modulation, and detection of light using semiconductor devices, and elements of optocommunication systems.

474. Nano-Optics
(Same as OPT 469)
Examination of theory of strongly focused light, confocal and nearfield optical microscopy, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, and optical forces.

476. Polymer Synthesis
An introduction to polymerization reaction mechanisms. The kinetics of commercially relevant polymerizations are emphasized along with a discussion of important, contemporary polymerization schemes. Approaches to functionalize polymers and surface-initiated polymerizations will also be covered. An overview of polymer characterization techniques, emphasizing compositional analysis, will be presented. The course is intended for graduate students in Chemical Engineering, Chemistry, Materials Science, and Biomedical Engineering, but advanced undergraduates are welcome.

480. Intro to Materials Science

482. Proc Microelec Device
This course features an overview of processes used in the fabrication of microelectronic devices, with emphasis on chemical engineering principles and methods of analysis. Modeling and processing of microelectronic devices. Includes introduction to physics and technology of solid state devices grade silicon, microlithography, thermal processing, chemical vapor deposition, etching and ion implantation and damascene processing. (Fall)

485. Thermodynamics & Stat Mech
Introduction to the topic: Thermodynamics and Statistical Mechanics. In the beginning macroscopic thermodynamics including phase equilibria and stability concepts will be covered followed by material related to the principles of statistical mechanics. Applications to various modern areas of the topic will be examined including the Monte Carlo simulation method, critical phenomena and diffusion in disordered media. The course will require completion of a project as well as regular homework assignments.

489. Biosensors

491. Masters Reading Course

492. Special Topics

493. Masters Essay

494. Masters Internship

495. Masters Research

496. Msc Graduate Seminar

497. Teaching Materials Science

507. Sem Practicum
Overview of techniques for using the SEM (Scanning Electron Microscope) and Scanning Probe (AFM, STM) and analyzing data. Students perform independent lab projects by semester’s end.

520. Spin Based Electronics
Up until now CMOS scaling has given us a remarkable ride with little concern for fundamental limits. It has scaled multiple generations in feature size and in speed while keeping the same power densities. However, CMOS finally encounters fundamental limits. The course is intended for students interested in research frontiers of future electronics technologies. The course begins with introduction to the basic physics of magnetism and of quantum mechanical spin. Then it covers aspects of spin transport with emphasis on spin-diffusion in semiconductors. The second part of the course is comprised of student and lecturer presentations of selected spintronics topics which may include: spin transistors, magnetic random access memories, spin-based logic paradigms, spin-based lasers and light emitting diodes, magnetic semiconductors, spin-torque devices for memory applications and the spin Hall effect.

591. Reading Course in Mat Scienc

591A. Independnt Study in Absentia

592. Special Projects
Mechanical Engineering

Professors Betti, Collins, Funkenbusch, Genberg, Lambroupolous (Chair), Perucchio, Ren
Associate Professor Muir
Assistant Professors Abdolrahim, Aluie, Askari, Dias, Kelley, Sekkow, Shang
Joint Appointments: Professor Waugh; Associate Professor Lerner

The Department of Mechanical Engineering offers graduate work leading to both the MS and PhD degrees in mechanical engineering and in materials science. Applicants for admission are expected to have a general background in one of the following areas, depending on degree program and interest: engineering, physics, applied physics, applied mathematics, materials science, mechanics, metallurgy, or chemistry. It is required that applicants take the Graduate Record Examination (GRE). Scores from the Test of English as a Foreign Language or International English Language Testing System (TOEFL/IELTS) are required of foreign applicants.

Faculty research in the department falls into two broad categories: solid mechanics-materials science and fluid mechanics-plasma physics. Much of this work is interdisciplinary and takes advantage of links between the Department and the Laboratory for Laser Energetics (LLE), the Rochester Center for Biomedical Ultrasound (RCBU), and the School of Medicine and Dentistry (SMD), as well as the Departments of Physics and Astronomy (DPA), Biomedical Engineering (BME), the Institute of Optics, and the Program in Archeology, Technology, and Historical Structures (ATHS) in the College.

nonlinear optical materials and superconducting ceramics. Precision engineering and metrology: design of interferometers and precision platforms for manufacturing precision optical surfaces; metrology and performance of s-axis, CNC/CMM platforms; mechanics of discrete systems, granular mechanics, locomotion, and intrusion in complex media. Structural mechanics and seismic analysis of masonry heritage buildings (ATHS): numerical modeling of structure failure under static and dynamic conditions, analysis of construction sequence, application of virtual reality, and augmented reality to historic building engineering analysis.

Applications and research projects in fluid mechanics-plasma physics include fusion research (LLE, DPA) and high-energy density physics (HEDP); inertial confinement fusion and magnetic confinement fusion; hydrodynamic theory and simulations of inertial fusion implosions; experimental studies of laser-driven implosions; matter at extreme states; particle-in-cell simulations of laser-plasma nonlinear interactions; hydrodynamic stability and nonlinear waves (Rayleigh-Taylor instability and parametric instabilities); experimental studies of the scattering of radiation from laser-produced plasma; plasma diagnostics; the investigation of X-ray sources; experimental studies of the interaction of very short, high-intensity laser pulses with matter; particle acceleration in plasmas; magnetohydrodynamic equilibrium and stability of tokamak plasmas; plasma dynamics, kinetic theory and wave-particle interaction. Astrophysical magnetohydrodynamics (DPA): astrophysical fluid dynamics and magnetohydrodynamics. Fluid mixing and transport: mass transport in liquid metal batteries, metals casting, and other technologies; two-dimensional turbulence; fundamentals of scalar and reactive mixing; biophysical fluid mixing in the inner ear and in the brain’s waste disposal system. Low Reynolds number studies (COM): characterization of non-Newtonian fluids as applied to optics manufacturing, analytic and numerical studies of nonlinear lubrication dynamics as in web transport and related problems, surface roughness.

PhD Program
The PhD degree requires 90 semester hours of graduate credit. A typical program includes about 40 to 60 hours of coursework, with the remaining hours in PhD research. Candidates are required to take at least 32 hours of coursework at the 400 level or higher, of which at least 24 should be in mechanical engineering courses. Each student is assigned a faculty advisor, who should be consulted in choosing the remaining courses.

Opportunities for research are provided during the academic year and the summer following the first year in residence. Students are expected to take advantage of these opportunities to help them choose a dissertation advisor and to begin what may become their eventual dissertation work.

All students must take a preliminary examination near the end of their second semester in residence. Each student’s performance on this exam, along with course grades and research aptitude, are considered in a faculty evaluation of his or her progress. Passing the exam with a positive faculty evaluation is a requirement for continuation in the PhD program.

Students who pass the preliminary exam and faculty evaluation are expected to take an oral PhD qualifying exam early in their third year of graduate study. Research from the first and second years may form the basis for this exam, which emphasizes material from the student’s field of study.

Because of the increasingly interdisciplinary nature of engineering, opportunities also exist for the pursuit of joint PhD programs between mechanical engineering and materials science, or mechanical engineering and biomedical engineering. Students in the joint programs must satisfy the degree requirements of both programs. Admissions and examinations are administered by faculty from both programs involved.

MS Program
The MS degree requires 30 semester hours of graduate credit. For candidates in Plan A, 6 to 12 hours of the 30 required will be for MS research leading to a master’s thesis. Of the remaining 18 to 24 hours, at least 16 must be in courses at the 400 level or higher and at least 12 of these 16 must be in ME courses.

Candidates in Plan B must take at least 18 of the required 30 hours in the Department of Mechanical Engineering, and at least 16 of these 18 must be in courses at the 400 level or higher, excluding reading and research courses. They must also pass a comprehensive examination taken during their final year of MS studies. Those candidates for the MS degree under Plan B who do not intend to continue on for a PhD have the option of substituting an oral examination for the comprehensive examination noted above. This examination may not be taken until after the completion of the MS course program. The oral examination must then be held within one year of such completion. Students failing either examination may be permitted, at the discretion of the department, to retake the examination at a later time.

Students seeking the MS degree in mechanical engineering will normally take a program which emphasizes courses in the various energy and mechanics areas. Those seeking an MS degree in materials science will normally take a program which emphasizes courses in the materials area. Materials science degree requirements and a list of graduate courses which are particularly appropriate may be found in the section on the Materials Science Program (page 171).

All courses in the Department of Mechanical Engineering are taught by full-time faculty members with professorial rank or by part-time faculty members with the rank of lecturer (part time) or professor (part time). Graduate students may assist as graders and conduct some of the recitation classes.

400. Applied Boundary Value Prob
This course covers the classical partial differential equations of mathematical physics: the heat equation, the Laplace equation, and the wave equation. The primary technique covered in the course is separation of variables, which leads to solutions in the form of eigenfunction expansions. The topics include Fourier series, separation of variables, Sturm-Liouville theory, unbounded domains and the Fourier transform, spherical coordinates and Legendre’s equation, cylindrical coordinates and Bessel’s equation. The software package Mathematica will be used extensively. Prior knowledge of Mathematica is helpful but not essential.
the last two weeks of the course, there will be a project on an assigned topic. The course will include applications in heat conduction, electrostatics, fluid flow, and acoustics. (Fall)

401. Mathematical Methods
Mathematical methods for obtaining approximate analytical solutions to differential equations that cannot be solved exactly. Particular attention will be given to the following methods: Boundary Layer Theory, WKB Theory, Multiple-Scale Analysis, Asymptotic Expansion of Integrals (method of stationary phase, method of steepest descents), Renormalization group. (Spring)

402. Partial Differential Equations
Prerequisites: ME 201, MTH 282
The course covers first-order equations and the theory of characteristics, classification of second-order linear equations, method of separation of variables, Green’s functions, and some numerical methods.

403. Numerical Methods
Prerequisites: ME 402 or PHY 402 (maybe taken w/ OPT 411, or consent w/ instructor. Some Matlab preferred.
Review of numerical solutions of ODE’s including stability and related concepts, boundary value problems, shooting methods; computational methods for PDE’s; consistency and stability analysis (von Neumann, Kreiss), differential approximations, analysis of implicit methods, applications from hydrodynamics (Navier-Stokes), elliptical problems with non-constant coefficients, wave propagation in finite and infinite domains. At the conclusion of this course, the student should be comfortable with modern super computing techniques to solve physical problems of interest for his/her dissertation research. (Spring)

404. Computational Methods Applied to Biological Systems
Prerequisites: Fundamental linear algebra, ordinary differential equation, some experience of Matlab
The course deals with computational methods to analytically intractable mathematical problems in biological research. For the first half of the course, general numerical analysis topics are reviewed such as linear algebra, ODE and PDE. Through homework assignments, students write their own computer code. Sufficient sample solutions are given to practice various numerical methods within limited time. The rest of the course is comprised of case studies and projects. Examples of computational analyses are drawn from life science problems such as biodynamics of human loco motion, ion channel kinetics, ionic diffusion, and finite element analysis of cells/tissues. For final project, students bring their own research problems, express them in mathematical equations, solve them using custom written computer programs and interpret the solutions. (Spring)

405. Dynamical Systems
Plane autonomous systems: phase plane, stability of equilibrium by linearization; stability by Liapunov methods; periodic solutions and their stability; global phase portraits; bifurcations. Higher order autonomous systems: matrix methods for linear systems; local behavior near equilibrium points; Lorenz equations and chaotic solutions; tent map and Lorenz equations; Liapunov exponents. Driven systems: Duffing’s equation; the driven pendulum. (Spring)

407. Advanced Dynamics
Prerequisites: ME 201, 211, 213; ME/MTH 163. ME 201 or higher strongly recommended
Description: Review of principles of mechanics. Some techniques from the calculus of variations. Generalized coordinates and constraints (holonomic and nonholonomic). Kinematics of rigid body motion. Hamilton’s principle and Lagrange’s equations of motion. Hamilton’s equations of motion. Modeling and numerical simulation of engineering systems. Other topics as time allows. (Fall Spring)

408. Phase Transformation
Prerequisite: ME 280 or equivalent
How and why atomic rearrangements leading to phase transformations occur and how they are associated with kinetic and crystallographic features; liquid-solid and solid-solid transformations, nucleation theory, growth, massive and martensitic transformations. (Fall)

412. Visco in Bio Tissues
Viscoelastic materials have the capacity to both store and dissipate energy. As a result, properly describing their mechanical behavior lies outside the scope of both solid mechanics and fluid mechanics. This course will develop constitutive relations and strategies for solving boundary value problems in linear viscoelastic materials. In addition, the closely-related biphasic theory for fluid-filled porous solids will be introduced; An emphasis will be placed on applications to cartilage, tendon, ligament, muscle, blood vessels, and other biological tissues. Advanced topics including non-linear viscoelasticity, composite viscoelasticity and physical mechanisms of viscoelasticity will be surveyed.

424. Introduction Robust Design & Quality Engineering
Prerequisite: ME 164 or equivalent
Definition and pursuit of “quality” as a design criterion. The concept of robust design. Selection of the quality characteristic, incorporation of noise, and experimental design to improve robustness. Analysis and interpretation of results. (Spring)

432. Opto-Mechanical
The mechanical design and analysis of optical components and systems will be studied. Topics will include kinematic mounting of optical elements, the analysis of adhesive bonds, and the influence of environmental effects such as gravity, temperature, and vibration on the performance of optical systems. Additional topics include analysis of adaptive optics, the design of lightweight mirrors, thermo-optic and stress-optic (stress birefringence) effects. Emphasis will be placed on integrated analysis which includes the data transfer between optical design codes and mechanical FEA codes. A term project is required for ME 432. (Spring)
434. Introduction to Plasma Physics I  
Prerequisite: PHY 217 or OPT 262  
Basic plasma parameters; quasi-neutrality, Debye length, plasma frequency, plasma parameter, Charged particle motion: orbit theory. Basic plasma equations; derivation of fluid equations from the Vlasov equation. Waves in plasmas. MHD theory. Energy balance. (Fall)

435. Introduction to Plasma Physics II  
Prerequisite: ME 434 or consent of the instructor  
Vlasov equation, Landau damping, VanKampen modes, two-stream instability, micro-instabilities, introduction to kinetic theory, shield clouds, Thomson scattering, and the Fokker-Planck equation. (Spring)

436. Compressible Flow  
Prerequisites: ME 225 and ME 201 or MTH 281  
Kinematics, equations of motion; thermodynamics of gases; linear acoustics; Bernoulli equation; potential flow; steady one-dimensional flow; shock waves, normal and oblique shocks; unsteady one-dimensional flow, characteristics. Applications in engineering and astrophysics. (Spring)

437. Incompressible Flow  
Prerequisites: ME 225, ME 201 or MTH 281  
The study of incompressible flow covers fluid motions which are gentle enough that the density of the fluid changes little or none. Topics: Conservation equations. Bernoulli’s equation, the Navier-Stokes equations. Inviscid flows; vorticity; potential flows; stream functions; complex potentials. Viscosity and Reynolds number; some exact solutions with viscosity; boundary layers; low Reynolds number flows. Waves. (Fall)

439. Turbulence  
Prerequisites: ME 225, ME 201, ME 400  
This is an introduction to turbulence theory and modeling for graduate students in engineering and the physical sciences. This course stresses intuitive physical understanding, mathematical analysis techniques, and numerical methodologies. It will highlight applications in various disciplines, including aeronautics, fusion sciences, geophysics and astrophysics. (Spring)

440. Structural Mechanics  
Prerequisite: ME226 ME213  
Application of energy methods to obtain the governing equations and approximate solutions to problems involving elastic structures. Static models will be developed to determine the maximum displacements and stresses for structures subjected to forces. Dynamic models will be developed to determine approximate natural frequencies and mode shapes. Rayleigh-Ritz and Galerkin approximation methods will be covered. (Fall)

441. Finite Elements  
Prerequisites: MTH 164 & MTH 165, ME 226 and familiarity with Matlab  
This course provides a thorough grounding on the theory and application of linear finite element analysis in solid mechanics and related disciplines. Topics: structural matrix analysis concepts and computational procedures; shape functions and element formulation methods for 1-D, 2-D problems; variational methods, weighted residual methods and Galerkin techniques; isoparametric elements; error estimation and convergence; global analysis aspects. Term project and homework require computer implementation of 1-D and 2-D finite element procedures using Matlab. Term project not required for ME254. (Spring)

443. Applied Vibration Analysis  
Prerequisites: ME 226, ME213  
Deformations and the stresses in different types of structural systems subjected to prescribed dynamic loading conditions. Topics include: overview of structural dynamics, matrix structural analysis and Finite Element analysis, single-degree and multi-degree-of-freedom systems, linear and inelastic systems, numerical evaluation of dynamic response, Finite Element methods in dynamic analysis, earthquake response and structural design. (Spring)

444. Continuum Mechanics  
Prerequisites: Basic ordinary and partial differential equations, linear algebra, undergraduate fluid mechanics (ME225) and solid mechanics (ME226).  
Course Description: The mechanics of continuous media. The basic notations and concepts in applied mechanics will be covered. These concepts are the foundation for both solid and fluid mechanics and applications in both of these areas will be used as examples. The course will include 1) indicial notation and tensor analysis, 2) concepts of stress, 3) both Eulerian and Lagrangian descriptions of deformation and strain, 4) conservation of mass, momentum, energy, and 5) constitutive equations to describe material response. (Fall)

445. Precision Instrument Design  
This course focuses teaching the multidisciplinary aspects of designing complex, precise systems. In these systems, aspects from mechanics, optics, electronics, design for manufacturing/assembly, and metrology/qualification must all be considered to design, build, and demonstrate a successful precision system. The goal of this class is to develop a fundamental understanding of multidisciplinary design for designing the next generation of advanced instrumentation. (Fall)

449. Elasticity  
Prerequisite: ME226; ME163 or MTH163  
Analysis of stress and strain; equilibrium; compatibility; elastic stress-strain relations; material symmetries. Torsion and bending of bars. Plane stress and plane strain; stress functions.
Applications to half-plane and half-space problems; wedges; notches. 3-D problems via potentials. (Spring)

451. Characterization Methods in Materials
Prerequisite: ME 280 or equivalent

Crystallography, symmetry elements, space groups, x-ray diffraction from single crystals and powder patterns. Fourier transforms, grain size effects, residual stresses and textures, diffuse and small angle scattering, Bragg and Laue x-ray diffraction topography, thin films and epitaxial layers. Modern x-ray software for diffraction analysis including textures, residual stresses, pattern identification and Rietveld applications. (Fall)

453. Intro to Nuclear Engineering
Prerequisites: MTH 163, Ordinary Differential Equations, or equivalent ME 122, Computational Methods in Mechanical Engineering, or equivalent PHY 123, Modern Physics (recommended)

A first course in nuclear engineering with emphasis on the fundamental physics and technology of modern water-cooled power reactors, the nuclear fuel cycle, and the regulatory environment surrounding nuclear power in the United States

458. Non-Linear Finite Elements
Prerequisite: ME441 (can be taken concurrently) or permission of instructor.

The theory and application of nonlinear FE methods in solid and structural mechanics, and biomechanics. Topics: review and generalization of linear FE concepts, review of solid mechanics, nonlinear incremental analysis, FE formulations for large displacements and large strains, nonlinear constitutive relations, incompressibility and contact conditions, hyperelastic materials, damage plasticity formulation, solution methods, explicit dynamic formulation. (Spring)

460. Thermodynamics of Solids

Review of basic thermodynamic quantities and laws; equations of state; statistical mechanics; heat capacity; relations between physical properties; Jacobian algebra; phase transformations, phase diagrams and chemical reactions; partial molar and excess quantities, phases of variable composition; free energy of binary and multicomponent systems; surfaces and interfaces. The emphasis is on the physical and chemical properties of micro and nano solids including stress and strain variables. (Spring)

461. Fracture & Adhesion
Prerequisites: ME 280, 226

Stress fields near cracks in linear elasticity. Linear elastic fracture mechanics. Griffith fracture theory. K and J approaches to fracture. Failure analysis and fracture stability; crack tip deformation, crack tip shielding. Crack nucleation. Adhesion. Low cycle fatigue; fatigue crack propagation. Emphasis on the role of microstructure in determining fracture, adhesion and fatigue behavior of materials; improving fracture toughness for advanced materials especially ceramics and polymers. This course is taught at a level that brings the student to the level of current research. (Fall)

462. Solids & Materials Lab
Prerequisites: ME280, ME226

Lecture and laboratory. Lecture: engineering problem solving methodologies and review of basic statistics. Laboratory: dealing with solids/materials instrumentation Students work in groups of three. Graduate students work alone on independent projects. (Fall)

463. Microstructures
Prerequisite: ME 280


466. Corrosion

A scientific approach to understanding the oxidation and dissolution of metals related to corrosion control, electrical energy generation, metallic plating, and energy storage. Characterization of corrosion types. Interfacial electrochemical mechanisms, thermodynamics, electrode potentials, interphases, and Pourbaix diagrams. Kinetics of free corrosion and electron limited corrosion including polarizations and overpotentials. Passivity. Tafel behavior with Butler-Volmer interpretations. Experimental measurements used in corrosion research and in battery research. Corrosion in iron based and aluminum based aqueous systems. Corrosion in lithium and sodium based non-aqueous systems. Effects of stress, including mechanisms of stress corrosion cracking related to metallurgical structure and role of the electrical double layer. Catalytic behavior of free surface nanostructures intended to catalyze oxygen reactions and ease barriers to metallic plating and ionic dissolution at polar electrolyte interfaces.

481. Mechanical Behavior of Solids
Prerequisites: ME 280, MTH 163 or equivalent

The mechanical response of crystalline (metals, ceramics, semiconductors) and amorphous solids (glasses, polymers) and their composites in terms of the relationships between stress, strain, damage, fracture, strain-rate, temperature, and microstructure. (Spring)

482. Biosolid Mechanics

483. Biofluid Mechanics
Prerequisite: ME 226 or equivalent

Application of engineering mechanics to biological tissues with an emphasis on orthopedic biomechanics. Includes an investigation of structure-function relationships in cartilage, bone, soft tissues and blood cells, as well as static analyses of the musculoskeletal system at the joint level. Techniques for modeling complex biological material properties such as composites, poroelasticity, finite elasticity, and viscoelasticity will also be presented. (Fall)
491. Master’s Reading Course in Me

492. Spec Top: High Energy Density Phy

Precision Engineering is used to design and develop sensors, systems, and instruments which are generally multidisciplinary and require simultaneous consideration of many facets to achieve a desired specification. This includes systems like displacement and surface interferometers, high speed machining centers, lithography tools, and diamond turning machines. Precision engineering is used to push the current state of the art into new frontiers. The goal of this class is to develop a fundamental understanding of the tools and techniques used for designing, assessing, and ultimately implementing precision systems.

493. Master’s Essay

494. Masters Internship

495. Master’s Research in Me

496. Current Research in Mechanics

532. Magnetohydro Dynamics

A general introduction to magnetohydrodynamics (MHD), with applications in engineering and astrophysics. The MHD approximation, basic equations, boundary conditions. The induction equation, the magnetic Reynolds number; perfectly conducting fluids, frozen-in magnetic fields; kinematic MHD, combined convection and diffusion of magnetic fields. Magnetic equilibria, magneto-atmospheres, magnetic buoyancy; force-free fields. Alfven waves, magneto-acoustic waves, magneto-atmospheric waves, MHD shock waves. Magnetic flux tubes: tubes; waves, siphon flows. Viscous flows: MHD channel flows, Hartmann boundary layers, electromagnetic pumps and flow meters; vorticity in MHD flows. Stability of magnetohydrostatic configurations: kink and sausage instabilities, convective instability. Dynamo theory: Cowling’s theorem, the mean-field dynamo equations, the alpha effect, solar and stellar dynamos, interface dynamos, nonlinear dynamos. (Spring)

533. Intro-Inertial Confinement Fusion


535. Laser Plasma Interactions


536. Inertial Confinement Fusion

Introduction to probability theory, stochastic processes, and statistical continuum theory. Experimental facts of turbulent motion. Kinematics and dynamics of homogeneous turbulence.

541. Nanoscale Crystalline Defect

545. Adv Topics in Plasma Physics

Prerequisite: ME 434 or permission of instructor.

The course will discuss the physical principles of selected diagnostics used for plasma measurements. This includes measurements of density, temperature, current, magnetic field, refractive index, emitted and scattered electromagnetic radiation, radiation properties etc. The emphasis lays on a systematic presentation from first principles that will help to form the basis for gaining understanding of many applications in plasma physics. We will concentrate on laboratory plasma diagnostics from the perspective of controlled fusion research.

591. PhD Reading Course in Me

594. Research Internship

595. PhD Research in Me

595A. PhD Research in Absentia

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Masters Dissertation

899. Master’s Dissertation

899A. Masters Dissertation in Absentia

985. Leave of Absence

986V. Full Time Visiting Student

987V. Part Time Visiting Student

990. Summer in Residence

995. Cont of Doctoral Enrollment

997. Doctoral Dissertation

997A. Doctoral Dissertation in Absentia

999. Doctoral Dissertation

999A. Doctoral Dissertation in Absentia

999B. In-Absentia Abroad
The Institute of Optics

Professors Agrawal, Alonso, Boyd, Brown, Carney (Director), Fienup, Guo, Knox, Moore, Rolland, Stroud, Wicks, Williams, Zhang
Associate Professors Bentley, Berger, Marcian, Vamivakas, Zavislan
Assistant Professors Cardenas, J. Kruschwitz, Renninger

The Institute of Optics is devoted to teaching and research in optics and optical engineering offering programs leading to BS, MS, and PhD degrees. Instruction and research are offered in virtually every phase of optics, including physical optics, optical instrumentation and design, quantum optics, laser engineering, signal processing, guided wave optics, nonlinear optics, and optical materials. Well-equipped laboratories allow student thesis research in a wide range of areas including gradient index optics, image processing, integrated optics, dielectric thin films, ultrahigh resolution laser spectroscopy, and high-power laser physics.

A great deal of optics-related research is carried out in other parts of the University. These programs are described in other parts of this bulletin under the headings Center for Visual Science, Laboratory for Laser Energetics, Electrical and Computer Engineering, and Physics and Astronomy.

There is no foreign language requirement for graduate students in optics. Entering students ordinarily have a BS in physics, engineering, or mathematics, with a grade-point average of 3.0 or better. Scores from either the Test of English as a Foreign Language (TOEFL) or from the International English Language Testing System (IELTS) are required of foreign applicants, unless they are graduates of an undergraduate program where the primary language of instruction is English.

Catalog supplements providing the most recent information on course content and faculty research may be obtained on request from the Institute of Optics.

PhD Degree Program in Optics

It is expected that students completing this program in optics will be ready to assume a role as independent researchers in a university, industrial, or government laboratory. Most of the time in the program is devoted to learning specialized research skills and carrying out thesis research. However, it is also important that the students master the subject matter and develop a breadth of interest in the whole field of optics. To this end, a set of required core courses, a number of elective courses, and a preliminary examination are included in the program.

First-year financial support is usually in the form of a fellowship allowing each student to devote full time to coursework. The full load is 16 hours of credit per semester, which is typically done by taking four courses. The purpose of the first year of coursework is to provide a broad background in optical physics and engineering. First year courses recommended include Mathematical Methods for Optics, OPT 411; Geometrical Optics, OPT 441; Instrumental Optics OPT 442; Radiation and Detectors, OPT 455; Fourier Optics, OPT 461; Electromagnetic Waves, 462; and Quantum Mechanics for Optics, OPT 412, as well as one elective course. With the exception of the elective, these courses are core courses and are normally required for a PhD. They can be waived by submitting a petition to the Graduate Committee. Petitions are typically considered in cases where a course requirement may seem inappropriate for a student with an unusual background or interests. Students should consult the schedule of courses to determine what courses are available each semester to plan accordingly. It is possible for the elective chosen to be a course that will cover some of the material included in the preliminary examination. Students that are interested in engaging in research early on can substitute the elective with research credits under the supervision of a faculty member.

At the beginning of their second year of residence, students take a written preliminary examination, which covers the content of the first year of graduate study plus additional topics. In the second year of residence, students take courses in advanced subjects and concentrate in a specialty area in preparation for their PhD research. Students should become familiar with research opportunities available and discuss possible thesis topics with their advisor. This discussion leads to the preparation of a research proposal. Students will need to file a Program of Study Form, which is required before the end of the summer. Students usually fulfill their teaching requirement during their second year, which consists of two semesters of service. This service is required whether or not the students have received financial support from the University. Note that to be considered a full-time graduate student, the College requires a minimum of 12 credit hours per semester, or 9 hours for a Teaching Assistant (TA) or Research Assistant.

Soon after the beginning of their third year, or earlier, students prepare a written thesis proposal, which forms the basis for the oral qualifying examination.

The remainder of the PhD program is spent in advanced coursework and research, culminating in the writing and defense of a PhD thesis.

The PhD program is normally completed in four to six years.

MS Degree Program in Optics

The Master of Science Degree Program in Optics is designed to provide students, who have strong undergraduate preparation in physics, electrical engineering, or optics, with additional knowledge and skills to contribute to state-of-the-art optics research and development. A number of options are available within the general degree requirements to satisfy the needs of students with a variety of goals in mind.

A minimum of 30 semester hours of credit is required for the MS degree. Normally, no more than 10 hours are accepted as transfer credits, and those must be approved by the Graduate Committee as well as the dean of graduate studies. The MS Degree Program in Optics is available to both full-time and part-time students. As outlined under general University regulations in this bulletin, the MS degree can be pursued under either Plan A or Plan B—which is offered in two different forms—and may also be accomplished by choosing the MS Cooperative Program route.
There is a required set of core courses common to all of
the MS program options mentioned above, they are as follows:
Foundations of Modern Optics, OPT 443; Wave Optics and Im-
ing, OPT 465; a laboratory course, OPT 456; and Detection
of Optical Radiation, OPT 423. The laboratory course is not
required for part-time students; however, they must take another
course in its place. The remaining credits are obtained by taking
elective courses or through research credits, depending on which
plan has been selected. The grade-point average of all courses
counted toward the degree must be a 3.0 (“B”) or greater.

The various options and exceptions to these general rules are
described below.

**Plan A: Thesis Route**
The requirements are the core requirements listed above, plus
one or two additional 400-level optics courses along with thesis
research, a written MS thesis, and a successful final defense of
the MS thesis. Credit for the thesis may not be less than 6 credit
hours and not more than 10 credit hours. A successful thesis
must show evidence of independent work based in part upon
original material. Each candidate is expected to demonstrate a
strong ability to plan study over a prolonged period, present the
results in an orderly fashion, and display a thorough acquaint-
ance with the literature of a limited field. This option generally
requires 18–24 months (34 semesters) to complete as facilitates
the development of a high level of expertise within a specialized
field.

**Plan B: Non-thesis Route**
The standard requirements for both of the options available
under Plan B also include the core requirements listed above
and one additional course in each of the following areas (3 in
total): physical optics, quantum optics, and geometrical optics.
One additional course is also required in order to reach the
required 30 credit hours. This option concludes with the success-
ful completion of a research essay. Elective courses offered are
normally 400-level specialized courses in optics. The second way
to meet the MS degree requirements under Plan B (non-thesis
route) can be accomplished by pursuing an alternative set of
requirements allowing for a more concentrated program of study
in certified specialty areas. Please note that a research essay is
required for this option as well. Specialty areas of study include
Optical Communications, Electo-optics/Nonlinear Optics,
Optical Materials, Laser Engineering, Medical Optics, Image
Science, Optical Design, Fabrication and Testing, Photonics, and
Business Administration. The timeline for this option is similar
to the standard Plan B option with some of the required courses
replaced with courses specific to the specialty. The Certified
Specialty option allows for coursework to be more concentrated
in a particular area than the standard, more generalized Plan B
option. Both Plan B options can be completed within 2–3 se-
mers dependent upon whether or not the student chooses to
add a summer residency.

MS Plan B options are well suited for engineers and re-
searchers working in industry who desire advanced training in
optics. Courses taken on both of the paths can be completed
over a period of four or more semesters. All optics courses taken
by part-time students are the regular offerings taken by full-
time students. Required and elective courses are scheduled so
that several are available each semester in the late afternoon as
a convenience to part-time students. Part-time students should
consult the general University Master of Science degree regula-
tions online for information concerning maximum time limits,
reproactive credit, and transfer credit.

**MS Cooperative Program**
This option is ideal for students looking to combine formal
education with practical industrial experience. The curriculum
and requirements for this program are the same as those for our
regular MS programs. Admission to the cooperative program
is subject to the approval of the Graduate Committee. The
program consists of three blocks: (1) one four-month semester
of coursework at the University of Rochester; (2) a 12-month
period spent working in industry; and, (3) after the successful
completion of the co-op, an additional four-month semester
on campus in order to complete the MS program requirements.
During the year in industry, students are paid the normal salary
for employees with similar levels of experience. In order for stu-
dents to participate in the work block of the program, they must
satisfactorily complete the academic portions of the program.
Failure to do so will result in termination from the program.
Students will also be required to fulfill the normal conditions of
employment at the various corporations. The Institute of Optics
assists students in securing a co-op position in industry. During
the time students are employed in industry, they will remain
registered under a special co-op program and will have all of
the normal rights and privileges of matriculated students, even
though they are not in residence during that period.

For more information, please refer to the current Optics
Graduate Handbook, which can be found on the Institute of
Optics homepage.

**407. Sem Practicum**
Overview of techniques for using the SEM (Scanning Electron
Microscope) and Scanning Probe (AFM, STM) and analyzing
data. Students perform independent lab projects commensurate
with their graduate research.

**411. Math Meth for Optics & Phy**
Prerequisites: ME 201, 202 and permission of instructor
Advanced techniques utilizing vector calculus, series expansions,
contour integration, integral transforms (Fourier, Laplace and
Hilbert) asymptotic estimates, and second order differential
equations.

**412. Quantum Mechanics for Optics**
This course covers the topics in modern quantum theory which
are relevant to atomic physics, radiation theory, and quantum
optics. The theory is developed in terms of Hilbert space op-
erators. The quantum mechanics of simple systems, including
the harmonic oscillator, spin, and the one-electron atoms, are
reviewed. Finally, methods of calculation useful in modern
quantum optics are discussed. These include manipulation of coherent states, the Bloch sphere representation, and conventional perturbation theory. Prerequisite: One course in undergraduate wave mechanics or permission of instructor. References: Cohen-Tannoudji, Diu and Laloe, Merzbacher, Schiff, Dirac. (Spring)

413. Intro to Random Processes
Random signals and noise in linear systems. Selected topics in probability theory, random variables, random vectors, random sequences (random walk, Martingales, ARMA model, Markov chains), random processes (Poisson process, Gaussian process, Wiener process, Markov process), stationary and cyclostationary processes, random process inputs to linear systems, ergodicity, filtering, linear estimation, bandlimited and bandpass processes.

421. Opt Properties of Materials
Prerequisite: Undergraduate Quantum Mechanics
This is a course concerning the aspects of the solid state physics of semiconductors which influence their optical properties. Topics include: electrons and holes, bandstructures, k•p theory, Kramers-Kronig relations, phonons, polaritons, electrooptic effects, nonlinear optical effects. The physics of absorption, spontaneous and stimulated emission, reflection, modulation and Raman scattering of light will be covered. III-V semiconductors will be emphasized; other semiconductor material systems will also be mentioned. Optical properties of specific semiconductor material systems will be covered. Reduced dimensionality structures such as quantum wells will be contrasted with bulk semiconductors. Optoelectronic device applications of semiconductors will be mentioned, but not covered in detail. (Spring)

422. Color Technology
Color Technology is more than just pigments, dyes, paints, and textiles. Everywhere in modern technology (smart phones, tablets, displays, lighting, cinema, printers, etc.) is the need for a basic understanding of how we measure, identify, communicate, specify, and render color from one device to another. This course addresses color order systems, color spaces, color measurement, color difference, additive and subtractive color, and rendering of color images. The student will learn about color matching, lighting conditions, metamerism, and color constancy. At the semester’s end, each student will have compiled a Color Toolbox with useful functions to derive different necessary color values within MatLab.

425. Radiation & Detectors
The course covers the following topics: emission of thermal radiation, modeling of optical propagation (radiometry), quantifying the human perception of brightness (photometry) and of color (colorimetry), fundamentals of noise in detection systems, parameters for specifying the performance of optical detectors, and a survey of several specific types of lasers. References: Boyd, Radiometry and the Detection of Optical Radiation; Kingston, Detection of Optical and Infrared Radiation. (Fall)

427. Liquid Crystal Materials
This course will introduce the materials, terminology, effects, and devices used in the field of liquid crystal optics. Basic structures in nematic and cholesteric liquid crystals will be discussed and related to optical phenomena like transmittance, absorption, scattering, birefringence and selective reflection (the effect seen in scarab beetles and utilized to protect the OMEGA laser at LLE from blowing itself up). Two keys for device applications are LC chemical composition and molecular alignment, and these will be covered in order to understand the manufacture and operation of passive devices like wave plates and selective reflection polarizers. The basic electro-optics for active devices like EO switches and LC displays will also be covered. Other applications to be explored include mood rings, polarizing pigments for document security, smart windows, and car paint. (Spring)

429. Chm Bonds:from Molcls to Mat
An introduction to the electronic structure of extended materials systems from both a chemical bonding and a condensed matter physics perspective. The course will discuss materials of all length scales from individual molecules to macroscopic three-dimensional crystals, but will focus on zero, one, and two dimensional inorganic materials at the nanometer scale. Specific topics include semiconductor nanocrystals, quantum wires, carbon nanotubes, and conjugated polymers.

432. Opto-Mechanics
The mechanical design and analysis of optical components and systems will be studied. Topics will include kinematic mounting of optical elements, the analysis of adhesive bonds, and the influence of environmental effects such as gravity, temperature, and vibration on the performance of optical systems. Additional topic include analysis of adaptive optics, the design of lightweight mirrors, thermo-optics and stress-optics (stress birefringence) effects. Emphasis will be placed on integrated analysis which includes the data transfer between optical design codes and mechanical FEA codes. A term project is required. (Spring)

433. Opt Fab and Testing
You will be given a first-hand working knowledge of optical glasses, their properties, and the methods for specifying, manufacturing and testing high quality optical components. Lectures emphasize the optical and physical properties of glass, and how these influence the grinding and polishing process. Conventional fixed/loose abrasive grinding and pitch polishing are examined. New concepts for optical manufacturing are covered. The meaning of specifications will be reviewed. The laboratory portion of the course exposes you to abrasive grits, slurries, pitch polishing and the vagarious nature of the conventional polishing process, under the guidance of a master optician. Glass types and part shapes are assigned to illustrate the degree of difficulty required to achieve optical quality surfaces with hand and machine operations. In-process metrology is performed with a variety of instruments. (Spring)
440. Freeform Optics

441. Geometrical Optics
This course is designed to give the student a basic working knowledge of image-forming optical systems. The course is oriented towards problem solving. Material covered includes: image formation, ray tracing and first-order properties of systems; magnification, F/number, and numerical aperture; stops and pupils, telecentricity vignetting; telescopes, microscopes, magnifiers, and projection systems; the Delano diagram; the eye and visual systems, field lenses; optical glasses, the chromatic aberrations, and their correction; derivation of the monochromatic wavefront aberrations and study of their effects upon the image; third order properties of systems of thin lenses; effects of stop position and lens bending; aplanatic, image centered, and pupil centered surfaces; and field flatteners. References: Smith, Modern Optical Engineering, McGraw-Hill; Lecture notes. (Fall)

442. Instrumental Optics
Prerequisite: OPT 441
This course provides an in-depth understanding of the principles and practices of optical instrumentation: Optical metrology, including wavefront and surface metrology, interferometric instruments and interferogram analysis, coherence and coherence-based instruments, phase measurement and phase-shifting interferometry; spectroscopic instrumentation, including the Fourier transform spectrometer, the Fabry-Perot interferometer, and the grating monochromator; image plane characterization (star test, Ronchi test, and modulation transfer function); the influence of illumination and partial coherence on image forming systems, including microscopes, systems for projection lithography, and displays. (Spring)

443. Fund of Modern Opt Sys
This course covers fundamental ray optics that are necessary to understand today's simple to advanced optical systems. Included will be paraxial optics, first-order optical system design, illumination, optical glasses, chromatic effects, and an introduction to aberrations. References: Hecht, Optics (4th edition); Smith, Modern Optical Engineering; Lecture notes. (Fall)

444. Lens Design
Prerequisite: Permission of instructor

447. Advanced Optical Coating Design
Prerequisites: Optics 246/446, or special permission from Instructor.
This course will cover such topics as the effects of dispersion, scatter, and inhomogeneity in multilayer interference coating designs. Attention will be given toward manufacturability of designs and meeting common optical specifications. Design assignments will address fields including, but not limited to Ophthalmic, Lighting, Display, Anti-counterfeiting, Laser, and Infrared applications. Each student will be given access to current market design, optical characterization, and post-process analysis software. (Spring)

448. Vision and the Eye
This course will reveal the intricate optical and neural machinery inside the eye that allows us to see. It will describe the physical and biological processes that set the limits on our perception of patterns of light that vary in luminance and color across space and time, We will compare the human eye with the acute eyes of predatory birds and the compound eyes of insects. The course will also describe exciting new optical technologies for correcting vision and for imaging the inside of the eye with unprecedented resolution, and how these technologies can help us understand and even cure diseases of the eye. The class is intended to be accessible to advanced undergraduate students, especially those majoring in Optics, Biomedical Engineering, or Brain and Cognitive Science, but is recommended for anyone with a curiosity about vision or an interest in biomedical applications of optics. The course will also serve as an introduction to the study of vision for graduate students. (Spring)

450. Polarization
Prerequisites: OPT 441 or 443, and 461 or 463, or permission of the instructor.
This course covers the fundamentals necessary to understand the behavior of fully and partially polarized light, and the significant range of applications and optical systems in which polarization is important. Topics include foundational electromagnetic theories of propagation and scattering, polarized plane waves, polarization eigenstates, Jones and Mueller Calculii, ellipsometry, polarization in multilayers and gratings, principles of polarization effects in focusing and imaging, polarization metrology, and topics in polarization coherence.

452. Med Imaging-Theory & Implem
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Special attention on the Fourier transform relations and reconstruction algorithms of x-ray and ultrasonic-computer tomography, and MRI.
453. Quantum & Nano Opt Lab
This laboratory course (3 credits) will expose students to cutting-edge photon counting instrumentation and methods with applications ranging from quantum information to biotechnology and medicine. It will be based on quantum information, the new, exciting application of photon counting instrumentation. As much as wireless communication has impacted daily life already, the abstract theory of quantum mechanics promises solutions to a series of problems with similar impact on the twenty-first century. Major topics will be entanglement and Bells inequalities, single-photon interference, single-emitter confocal fluorescence microscopy, Hanbury Brown and Twiss correlations/photons antibunching. Photonic based quantum computing and quantum cryptography will be outlined in the course materials as possible applications of these concepts and tools. (Fall)

456. Optics Laboratory

461. Fourier Optics
Prerequisites: Undergraduate electromagnetic theory, advanced calculus, linear algebra.

The principles of physical optics including diffraction and propagation based on Fourier transform theory; integral formulation of electromagnetic propagation; diffraction from apertures and scattering objects; applications to optics of Fourier transform theory, sampling expansions, impulse response, propagation through optical systems, imaging and transforming, optical transfer function, optical filtering; and selected topics of current research interest. Text: Goodman, Introduction to Fourier Optics, 4th Ed.; class notes. (Fall)

462. Electromagnetic Waves
Prerequisites: Undergraduate electromagnetic theory, advanced calculus, vector analysis. References: Jackson, Classical Electrodynamics; Born and Wolf, Principles of Optics.

This course covers topics in electromagnetic theory that serve as a foundation for classical descriptions of many optical phenomena. A partial list of topics includes: review of Maxwell’s equations, boundary conditions, and wave equations; polarization of light; crystal optics; vector, scalar, and Hertz potentials; radiation from accelerated charges; electric and magnetic dipole radiation; Lorentz atom description of the interaction of light with matter; scattering; optical waveguides. (Spring)

463. Wave Optics & Imaging
Prerequisites: Advanced Calculus, Linear Algebra

This course provides the practicing optical engineer with the basic concepts of interference, diffraction, and imaging. Each topic will be reinforced with real-world examples. The interference section will include interferometry, Fabry-Perot etalons, and multilayer thin films. The diffraction and imaging sections will include, but are not limited to, diffractive optics, continuous and discrete Fourier transforms, convolution theory, and Linear Systems. References: Hecht, Optics (4th edition); Goodman, Introduction to Fourier Optics; Lecture notes. (Fall)

464. Nanophot/Nanomech Devices
Prerequisites: Base knowledge of the following subjects is required for this course: Electromagnetic waves (ECE230 or OPT262 or OPT462); Waveguides and optoelectronics (ECE235/435 or OPT226 or OPT468); Quantum mechanics (OPT223 or OPT412 or PHY237 or PHY407).

This course aims to provide students with the understanding of fundamental principles governing optical and mechanical phenomena at micro/nanoscale, with a focus on current research advances on device level. The following topics will be covered: Fundamental concepts of micro-/nanoscale optical cavities and mechanical resonators; various types of typical nanophotonic and nanomechanical structures; fabrication techniques; theoretical modeling methods and tools; typical experimental configurations; physics and application of optomechanical, quantum optical, and nonlinear optical phenomena at mesoscopic scale; state-of-the-art devices and current research advances. References: primarily based on recent literature

465. Principles of Lasers
Prerequisites: Undergraduate electromagnetic theory and quantum mechanics.

This course provides an up-to-date knowledge of modern laser systems. Topics covered include quantum mechanical treatments to two-level atomic systems, optical gain, homogenous and inhomogenous broadening, laser resonators and their modes, Gaussian beams, cavity design, pumping schemes, rate equations, Q switching, mode-locking, various gas, liquid, and solid-state lasers. (Spring)

467. Optical Engineering
This course aims to provide students with the understanding of fundamental principles governing optical and mechanical phenomena at micro/nanoscale, with a focus on current research advances on device level. The following topics will be covered: Fundamental concepts of micro-/nanoscale optical cavities and mechanical resonators; various types of typical nanophotonic and nanomechanical structures; fabrication techniques; theoretical modeling methods and tools; typical experimental configurations; physics and application of optomechanical, quantum optical, and nonlinear optical phenomena at mesoscopic scale; state-of-the-art devices and current research advances. References: primarily based on recent literature

468. Quantum & Nano Opt Lab
This laboratory course (3 credits) will expose students to cutting-edge photon counting instrumentation and methods with applications ranging from quantum information to biotechnology and medicine. It will be based on quantum information, the new, exciting application of photon counting instrumentation. As much as wireless communication has impacted daily life already, the abstract theory of quantum mechanics promises solutions to a series of problems with similar impact on the twenty-first century. Major topics will be entanglement and Bells inequalities, single-photon interference, single-emitter confocal fluorescence microscopy, Hanbury Brown and Twiss correlations/photons antibunching. Photonic based quantum computing and quantum cryptography will be outlined in the course materials as possible applications of these concepts and tools.

This course provides an up-to-date knowledge of modern laser systems. Topics covered include quantum mechanical treatments to two-level atomic systems, optical gain, homogenous and inhomogenous broadening, laser resonators and their modes, Gaussian beams, cavity design, pumping schemes, rate equations, Q switching, mode-locking, various gas, liquid, and solid-state lasers.
468. Waveguides & Optoelectronic Devices
This course covers the propagation and interactions in optical waveguides. Topics to be covered include: the Goos-Haenchen effect; modes on the planar waveguide; coupled-mode theory; modes on the optical fiber; pulse broadening in optical fibers; coupling between guided-wave structures; waveguide devices such as semiconductor lasers; fiber lasers and amplifiers; passive components and electro-optics devices. (Fall)

476. Biomedical Optics
Prerequisites: basic knowledge of quantum mechanics, statistical mechanics, linear algebra, differential equations, and vector calculus. Open to graduate students and upper-level undergraduates (who usually enroll in OPT 276, with fewer homework problems).

Biomedical spectroscopy (absorption, fluorescence, Raman, elastic scattering); propagation of photons in highly scattering media (such as tissue); techniques for high-resolution imaging in biological media: confocal imaging, multiphoton imaging and optical coherence tomography. Taught every other fall.

481. Gen Management of New Venture
This course provides an opportunity to examine the management practices associated with innovation and new business development. The analysis of entrepreneurship is evaluated from the perspective of start-up ventures and established companies. There is an appraisal of the similarities and differences in the skills and the functions required to develop successful projects in both types of situations. A range of management issues is discussed, including organizational development, analysis of market opportunities, financial planning and control, capitalization, sources of funds, the due-diligence process, and valuing the venture. Course Approach: To expose students to various facets of new venture management and entrepreneurship, classes will consist of lectures, evaluation of current business situation, and presentations by guest speakers. Furthermore, two (one for engineers) case studies must be prepared for the credit. (Spring)

482. Sys Integration & Prod Dev
Prerequisites: OPT 425, 441 or 443, and 461 or 463, or permission of the instructor.

In this class we will explore the ISO 9000 product development process and illustrate how to use this process to develop both products and research systems that meet necessary specifications. The class will use systems such as video projectors, CD-ROM drives, bar-code scanners and scanning laser microscopes as examples to illustrate the various concepts.

491. Master’s Reading in Optics

493. Master’s Essay

494. Master’s Internship

495. Master’s Research in Optics

533. Quantum Optics Atom Fld Int

544. Advanced Lens Design
Prerequisite: OPT 444

Complex zoom lenses and multi-mirror reflective systems are discussed detail starting with first principles. Other topics include materials for other wavelength bands, tolerancing, sensitivity analysis, Monte Carlo analysis, ghost and stray light analysis. Students required to complete two complex group design projects. (Fall)

551. Intro to Quantum Optics
Prerequisite: OPT 412 or PHY 407/408 or permission of the instructor.

An introduction to quantum and semiclassical radiation theory with special emphasis on resonant and near-resonant interactions between atoms and optical fields. Topics covered include field quantization, Weisskopf-Wigner and Jaynes-Cummings models, the optical Bloch equations, resonant pulse propagation, homogeneous and inhomogeneous broadening, adiabatic and non-adiabatic transitions, and dressed states. (Fall)

552. Quantum Opt of Em Field

591. PhD Reading Course

591B. Ind Study in Absentia

594. Internship

595. PhD Research in Optics

595A. PhD Research in Absentia

595B. PhD Rsrch in Absentia Abroad

596. Optics Colloquium

890. Summer in Residence

894. Co-Op Program in Optics

895. Cont of Master’s Enrollment

897. Master’s Dissertation

897A. Masters in Absentia

897B. Master’s in Absentia

899. Master’s Dissertation

899A. Masters Dissertatn Absentia

985. Leave of Absence
Interdisciplinary Master’s Programs

Arts, Sciences & Engineering in recognizing the diverse interests of students has developed and formalized interdisciplinary master’s programs. A standing committee of faculty acts as a “department” and supervises the program requirements for its students.

Alternative Energy

Professors 1Anthamatten, 1Chen, 1Chimowitz, 1Jorné, 2Krauss, 2Schroder, 3Sobolewski, 1Tang, 1Wu, 1Yates
Associate Professor 1D. Foster
Assistant Professors 1Shestopalov, 1Tenhaeff

This program is designed for graduate students with a bachelor’s degree in engineering or science who are interested in pursuing a technical career in alternative energy. Entering students must have completed two-semester courses in general chemistry, general physics, and calculus, in addition to one-semester courses in differential equations and thermodynamics, or their equivalents. Students deficient in these academic preparations are required to take bridging courses in addition to the degree requirements described below.

Degree Options and Requirements

The programs of study of all students must receive approval by their faculty advisors, the director of graduate studies in chemical engineering, and the dean of graduate studies in Arts, Sciences & Engineering. The Master of Science degree in alternative energy can be earned with Plan A (writing a thesis) or Plan B (not writing a thesis). Plans A and B are available to both full- and part-time students. Full-time students receiving stipends from grants or contracts, however, are expected to write a thesis Plan A under the sponsoring faculty advisors’ supervision.

Master of Science with Thesis (Plan A)

Students in Plan A must earn a minimum of 30 credit hours, at least 18 of which should be attributed to formal 400-level courses. The balance of the credit-hour requirement can be satisfied through independent reading (no more than four credit hours) and thesis research (at least six credit hours), culminating in a master’s thesis.

Master of Science without Thesis (Plan B)

Students in Plan B must earn a minimum of 32 credit hours of coursework acceptable as graduate credits, at least 24 of which should be attributed to formal 400-level courses identified and no more than 4 through independent reading. Students may opt for industrial internship (one credit hour), for which a final essay must be submitted as a part of their degree requirements. In addition to coursework and the essay, all Plan B students must pass a comprehensive oral examination as part of the degree requirements.

1. Department of Chemical Engineering
2. Department of Chemistry
3. Department of Electrical and Computer Engineering
Coursework Requirements

To fulfill the credit-hour requirements, students should include a minimum of three competency courses for Plan A, and at least four for Plan B, of which at least one must be selected from ERG 458, 460, 464, and 465. The courses identified below provide core competency in alternative energy, and the balance of the coursework requirement can be satisfied by taking technical electives (subject to availability) listed as follows:

Core Courses Competency in Alternative Energy
(A minimum of three for Plan A, at least four for Plan B, and at least ONE from starred (•) courses for both Plans A and B.)
• ERG 441. Advanced Transport Phenomenon
• *ERG 458. Electrochemical Engineering and Fuel Cells
• *ERG 460. Solar Cells
• *ERG 464. Biofuels
• *ERG 465. Sustainable Chemical Processes
• ERG 485. Thermodynamics and Statistical Mechanics
• ERG 488. Introduction to Energy Systems

Technical Electives
• ERG 455. Interfacial Engineering
• ERG 469. Biotechnology and Bioengineering
• ERG 486. Polymer Science and Engineering
• CHE 400. Applied Boundary Value Problems
• CHE 488. Introduction to Energy Systems
• CHM 456. Chemical Bonds: From Molecules to Materials
• CHM 462. Biological Chemistry
• CHM 486. Energy Science Technology and Society
• ECE 423. Semiconductor Devices
• ME 451. Crystallography and X-Ray Diffraction
• ME 481. Mechanical Properties of Solids
• OPT 407. SEM Practicum
• PHY 420. Introduction to Condensed Matter Physics
• TEM 492. Solar Energy and System Modeling
• ERG 491. Independent Reading (at most 4 credit hours)
• ERG 494. Industrial Internship (1 credit hour)
• ERG 495. Master’s Thesis Research

413. Engineering of Soft Matter

This course will provide an overview of several contemporary research topics pertaining to structured organic materials. Lectures will focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures will introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials. Homework assignments and a brief technical presentation will be required. Advanced undergraduate students are welcome. Offered even years. (Spring)

441. Adv Transport Phenomenon

Prerequisites: Graduate Student standing (or permission from instructor)

This course will acquaint the student with important topics in advanced transport phenomena (momentum, heat and mass transport). Topics include laminar and turbulent flow, thermal conductivity and the energy equation, molecular mass transport and diffusion with heterogeneous and homogeneous chemical reactions. Focus will be to develop physical understanding of principles discussed and with emphasis on chemical engineering applications. In addition to the text, the student will be exposed to classic and current literature in the field. (Fall)

454. Interfacial Engineering

458. Electrochem & Engg & Fuel Cell

The course will concentrate on presenting the principles of electrochemistry and electrochemical engineering, and the design considerations for the development of fuel cells capable of satisfying the projected performance of an electric car. The course is expected to prepare you for the challenges of energy conversion and storage and the environment in the 21st century. Course is offered October 24 - December 12. (Fall)

460. Solar Cells

This course will introduce students to the basics of photovoltaic devices: physics of semiconductors; pn junctions; Schottky barriers; processes governing carrier generation, transport and recombination; analysis of solar cell efficiency; crystalline and thin-film solar cells, tandem structures, dye-sensitized and organic solar cells. Students will learn about current photovoltaic technologies including manufacturing processes, and also the economics of solar cells as an alternative energy source. Critical analysis of recent advances and key publications will be a part of the course work. (Fall)

464. Biofuels

This course will provide the student with a grounding in the fundamental principles of biofuels, including their sources, properties, and the biological and chemical processes by which they are made. (Fall)

465. Sustainable Chem Processes

Prerequisites: Organic Chemistry I; Chemical Kinetics and Reactor Design

Elements of sustainable chemical processes. Generation of transportation fuels and chemical platforms from renewable resources-- e.g. lignocellulose, algae, and carbon dioxide-- for production of bulk and fine chemicals traditionally derived from petroleum. Use of environmentally benign solvents-- e.g. ionic liquids, supercritical carbon dioxide, fluorous solvents, and liquid polymer-- for reactions and separations. Chemical reactions activated by unconventional means-- e.g. ball milling, microwave heating, and ultrasound irradiation-- requiring minimum energy, catalyst, and solvent. Chemical and enzymatic catalysis enhanced
by process integration to minimize the need for product separation and purification. “Click reactions” applied to the synthesis of peptides and advanced materials. Microreactor technologies to maximize heat & mass transfer, reaction rate, product yield and selectivity, in addition to facilitating process control, optimization, and scale-up. (Spring)

469. Biotechnology & Bioengineering

472. Energy System Econ & Modeling

One of the goals for the course is to introduce basic economic principles and methodologies necessary to evaluate the economics of various energy options. Students will learn the basics of energy systems modeling using Powersim Modeling software. Students will also be introduced to various modeling tools from Sandia National Lab and National Renewable Energy Lab (NREL) for evaluating economics of energy options. Students should expect to have discussion about what it will take economically, technically, and politically to increase the role of renewable technologies into our energy systems. (Fall)

482. Proc Microelec Device

485. Thermodynamics & Stat Mech

Introduction to the topic: Thermodynamics and Statistical Mechanics. In the beginning macroscopic thermodynamics including phase equilibria and stability concepts will be covered followed by material related to the principles of statistical mechanics. Applications to various modern areas of the topic will be examined including the Monte Carlo simulation method, critical phenomena and diffusion in disordered media. The course will require completion of a project as well as regular homework assignments.

488. Intro to Energy Systems

The goal of this course is to provide a succinct introduction to the different means of producing energy. The first and second laws of thermodynamics are reviewed to introduce the concepts of conservation of energy and efficiency. Then these concepts are applied to a number of different energy technologies, including wind, hydroelectric, geothermal, fuel cells, biomass, and nuclear. For each type of technology, a technical introduction is given so that the student will understand the governing scientific principles. (Spring)

491. Master’s Reading in ERG

494. Masters Internship

495. Master’s Research

496. Research Seminar

497. Teaching Alt Energy

890. Summer in Residence - MA

895. Cont of Master’s Enrollment

897. Master’s Dissertation

897A. Masters Dissertation Absentia

899. Master’s Dissertation

899A. Mstrs Dissertatn in Absentia

990. Summer in Residence

Sustainability

Professors Anthamatten, Chen, Dye, Frontier, Garzione, Jorne, Poreda, Rothenberg, van Wijngaarden, Wu, Yates

Associate Professors Elder, Kessler, Petrenko, Rand, Rich

Assistant Professors Abar, Jusko, Murray, Weber

There is a growing need for professionals who have the experience and interdisciplinary training to craft innovative, practical solutions to provide energy, water, waste, and other goods and services in a more environmentally friendly, sustainable, and public health-conscious manner.

The Center for Energy and Environment helps students prepare to meet these needs by offering an MS in Sustainability. Our program blends a dynamic, interdisciplinary approach with individual mentoring to help students shape their course of study and crystallize their career plans. Students will benefit from a personalized, small program and the interdisciplinary resources of the University of Rochester’s highly ranked programs in environmental science, engineering, public health, and political science.

Our one-year master’s program teaches students the skills to understand and evaluate the environmental and public health impact of energy and other industrial production processes and usage and to suggest sustainable solutions. We provide students with a firm foundation in

• energy systems and alternative energy

• environmental geochemistry

• environmental health

• environmental law and policy

This foundation is supplemented by a robust offering of elective courses from which students can select to meet their individual needs.

This MS provides students with an opportunity to prepare for exciting new opportunities in sustainability, such as in alternative energy and policy development, as well as positions with companies, universities, nonprofits, consulting firms, government agencies, and other private and public institutions engaged in sustainability efforts addressing energy, environmental, and public health problems.
Master of Science without Thesis (Plan B)

The program in sustainability is only offered as a plan B or “coursework” master’s degree. It includes a minimum of 32 credits of required coursework and requires an exit examination. In addition to the coursework requirements and final examination, all students complete a practicum course. The practicum provides students with the opportunity to build experience while integrating principles from prior interdisciplinary coursework through either an internship, research project, outreach project or other suitable practicum. Students have a great deal of independence in the design of the capstone practicum experience, although we provide individual support and advice to students to help them explore a range of possibilities. At the end of their internship, research project, or outreach project, students produce a final product, such as a memorandum, report, or a poster detailing the work and findings. The suitability of the practicum to fulfill requirements for the degree are evaluated on a case-by-case basis. The practicum must have a sustainability-related focus and should be approved by the program director or codirectors in advance.

Professor Terry Noto advises students on the development of their student portfolio and résumé and the design of their capstone projects, tailored to each students career interests.

Program Admission Requirements

To be eligible for this program, you must have either a bachelor’s degree or a more advanced degree at the time of enrollment. Particularly strong applicants would have a BS degree in a relevant science, engineering, or social science discipline. All applicants must complete an online application and submit the following: (1) a personal statement, (2) official transcripts from all previous college and university programs, (3) three letters of recommendation from former instructors or employers, (4) official Graduate Record Examination (GRE) scores, and (5) a writing sample is optional but encouraged. In addition, an official TOEFL examination report is required from all applicants for whom English is not their primary language. The completed application will be reviewed by program faculty and by the Graduate Studies Office in Arts, Sciences & Engineering. Applicants who believe they are eligible for admission to the program but do not meet the usual program requirements can request a waiver. Program faculty discuss all waiver requests and waive requirements if there is a compelling reason for doing so, subject to the Dean of Graduate Studies’ approval. Students interested in a waiver should contact either the program director, Carmala Garziones, or the codirector, Edwin van Wijngaarden.

Coursework Requirements

Coursework includes five core courses and four elective courses, culminating in a core practicum course that provides students with an opportunity to gain valuable research, outreach, or work experience in or outside of the Rochester area.

CORE COURSES

Either CHE 488: Intro to Energy Systems or CHM 486: Energy: Science, Technology & Society
All four of the following:
- SUS 401: Environmental Health
- EES 416: Environmental Geochemistry
- SUS 426: Environmental Law and Policy
- SUS 499: Practicum (1–4 credits)

Technical Entrepreneurship and Management (TEAM)

Vice Provost for Entrepreneurship and Professor ’Moore
Senior Associate Dean ’Goettler
Professors ’Bocko, ’Lambropoulos
Associate Professors ’Anthamatten, ’Ding, ’McGrath, ’Zavislan
Clinical Assistant Professor ’Wojdat
Lecturer ’Wilson
Research Associate ’Ignatovich

The Center for Entrepreneurship administers the MS in Technical Entrepreneurship and Management (TEAM) Program, offered jointly by the Edmund A. Hajim School of Engineering & Applied Sciences and the Simon Business School.

Overview of the MS in TEAM

The emphasis for the TEAM master’s program is to combine a graduate-level technical education at the Hajim School with entrepreneurial management coursework at the Simon School. It is recommended that students pursue a different engineering focus than their undergraduate major. TEAM prepares students for industry work in a variety of engineering, analyst, management, and entrepreneurial roles and outfits aspiring entrepreneurs with skills to launch an enterprise. The degree offers various graduate-level courses in one of the following technical concentrations: (1) biomedical engineering, (2) chemical engineering, (3) computer science, (4) data science, (5) electrical and computer engineering, (6) energy and the environment, (7) mechanical engineering, (8) materials science, and (9) optics.

Familiarity with the chosen technical discipline is fostered by an emphasis on critical thinking, creativity, and innovation, all while being immersed in an educational and research environment. Students explore general business topics through an analytical lens, with a focus on organizing and managing resources and leadership. Students get exposure to real-world applications, including the opportunity to commercialize University of Rochester patented technologies.

- Requirements: three core entrepreneurship (TEM) courses, three technical elective courses, one additional technical or entrepreneurship management elective, one semester-long
practicum, and final comprehensive examination consisting of a written business plan and an oral presentation.

Admission
All applicants are required to submit the following materials along with the application: official transcripts; GRE or GMAT scores (optional); three letters of recommendation; and a personal statement. In addition, applicants must submit a tentative technical concentration from one of the nine areas listed above. A bachelor’s degree, or equivalent, in engineering, applied sciences, or mathematics is required.

Those applicants whose native language is other than English are required to submit TOEFL or IELTS scores as well.

Candidates must submit completed applications online at https://apply.grad.rochester.edu/apply/ by February 1. Supporting documents can be mailed to University of Rochester AIN Center for Entrepreneurship, 1-211 Carol Simon Hall, Box 270360, Rochester, NY 14627-0360 or faxed to (585) 276-2357. For more information, please call (585) 276-3500 or visit www.rochester.edu/team.

TEAM BIOMEDICAL ENGINEERING (TEB)

411. Cellular & Molecular Bio Found
Molecular biology, biochemistry, and genetics that are required to understand the biomedical and broader biological issues that affect our lives.

418. Intro to Neuroengineering
Prerequisites: BME260, strong math/computing skill recommended or permission of instructor

420. Biomedical Nanotech
This course is designed to provide students with detailed knowledge of the principles of nanotechnology and their applications in the biomedical field. Topics of study will include synthesis & assembly of nanoscale structures, lithography, and nanobiomaterials. Students will focus on biomedically-relevant topics such as cancer treatment, bone disorder, diabetes; and learn how nanotechnology is helping diagnose, treat, and understand these medical disorders. Recent innovative research in the biomedical field will be highlighted during discussions of the latest journal articles. At the end of the course, students will have an appreciation of the enormous potential of biomedical nanotechnology, its current, and future applications.

428. Physiological Control Sytms
Prerequisites: Math 163 or 165, ECE 241 or BME 230 (Can be concurrent)
This course introduces students to the theory and practice of control systems engineering. Topics include frequency domain modeling, time domain stability, transient and steady-state error analysis, root locus and frequency response techniques and feedback system design. Emphasis is placed on analyzing physiological control systems, but the concepts and design techniques are applicable and applied to a wide variety of other systems including mechanical and electrical systems. Graduate students will have more homework problems and additional exam problems.

442. Microbiomechanics
Prerequisite: permission of instructor
This course covers the application of mechanical principles to biotechnology and to understanding life at its smallest scales. Topics will vary with each course offering. Sample topics include force generation by protein polymerization, the mechanisms of bacterial motion, and the separation of biological molecules in porous media.

451. Biomedical Ultrasound
Prerequisites: Math 163, Math 164, Physics 122 or Permission of instructor
The course presents the physical basis for the use of high-frequency sound in medicine. Topics include acoustic properties of tissue, sound propagation (both linear and nonlinear) in tissues, interaction of ultrasound with gas bodies (acoustic cavitation and contrast agents), thermal and non-thermal biological effects of ultrasound, ultrasonography, dosimetry, hyperthermia and lithotripsy.

452. Med Imaging-Theory & Implemt
Prerequisite: ECE242
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Fourier transform relations and reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI.

453. Ultrasound Imaging
Prerequisite: BME230 or ECE241
This course investigates the imaging techniques applied in state-of-the-art ultrasound imaging and their theoretical bases. Topics include linear acoustic systems, spatial impulse responses, the k-space formulation, methods of acoustic field calculation, dynamic focusing and apodization, scattering, the statistics of acoustic speckle, speckle correlation, compounding techniques, phase aberration correction, velocity estimation, and flow imaging. A strong emphasis is placed on readings of original sources and student assignments and projects based on realistic acoustic simulations.
460. Quantitative Physiology
Prerequisites: ECE 113 or BME 210, or permission of instructor
A quantitative, model-oriented approach to physiological systems is presented. Topics include muscle and nerve tissue, the cardiovascular system, the respiratory system, the renal system, and a variety of neural systems.

462. Cell & Tissue Engineering
Prerequisites: BME 260, CHE225, CHE243 (or ME225), CHE244, BIO210, BIO250, CHM203 or permission of instructor
This course teaches the principles of modern cell and tissue engineering with a focus on understanding and manipulating the interactions between cells and their environment. After a brief overview of Cell and Tissue Engineering, the course covers 5 areas of the field. These are: 1) Physiology for Tissue Engineering; 2) Bioreactors and Biomolecule Production; 3) Materials for Tissue Engineering; 4) Cell Cultures and Bioreactors and 5) Drug Delivery and Drug Discovery. Within each of these topics the emphasis is on analytical skills and instructors will assume knowledge of chemistry, mass transfer, fluid mechanics, thermodynamics and physiology consistent with the Cell and Tissue Engineering Track in BME. In a term project, students must present written and oral reports on a developing or existing application of Cell and Tissue Engineering. The reports must address the technology behind the application, the clinical need and any ethical implications.

466. Bioprocess Engineering
Prerequisites: BIO110, CHM132, CHE243 or ME225, CHE244.
This course will explore the bioprocesses involved in producing a biopharmaceutical product (therapeutic proteins, cell therapy products, and vaccines). The course will take a stepwise journey through a typical production process from the perspective of a Bioprocess Engineer, starting with cell culture and moving downstream through purification and final fill. Engineering concepts involved in bioreactor design and control, cell removal/ recovery operations, and protein purification will be examined. The course will also provide an introduction to the analytical methods used to test biopharmaceutical products for critical quality attributes. The role of the regulatory agencies, like the US Food and Drug Administration, and the regulations that govern the industry will be introduced throughout the course in the context of the bioprocess to which they relate. Graduate students will need to complete a semester-end project in order to receive graduate credit for the course.

470. Biomedical Microscopy
Prerequisites: OPT 241, OPT 261, BME 201L, MTH 163/5, MTH 164 or permission of the instructor
This course covers the principles and practice of light microscopy as applied to biological and medical questions. Topics include basic light microscopy, DIC, phase epifluorescence, confocal and multiphoton laser-scanning microscopy, and selected methods such as CARS, FRET, FRAP, FCS, etc.

483. Biosolid Mechanics
Prerequisites: ME 226, BME 201 & 201P (or ME 120)
In this course, we will survey the role of mechanics in cells, tissues, organs and organisms. A particular emphasis will be placed on the mechanics of the musculoskeletal system, the circulatory system and the eye. Engineering concepts will be used to understand how physical forces contribute to biological processes, especially disease and healing. Experimental and modeling techniques for characterizing the complex mechanical response of biosolids will be discussed in detail, and the continuum mechanics approach will be highlighted.

511. Cell & Molecular Foundations

513. Mr Imaging: spines to Brains

890. Summer in Residence - MA

990. Summer in Residence

TEAM CHEMICAL ENGINEERING (TEC)

413. Engineering of Soft Matter
Prerequisites: CHM 203 (or equivalent) AND CHE 225 or CHM 251 (or equivalent)
This course will provide an overview of several contemporary research topics pertaining to structured organic materials. Lectures will focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures will introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials. Homework assignments and a brief technical presentation will be required. Advanced undergraduate students are welcome.

430. Organic Electronics

441. Adv Transport Phenomenon
Prerequisites: Graduate Student standing (or permission from instructor)
This course will acquaint the student with important topics in advanced transport phenomena (momentum, heat and mass transport). Topics include laminar and turbulent flow, thermal conductivity and the energy equation, molecular mass transport and diffusion with heterogeneous and homogeneous chemical reactions. Focus will be to develop physical understanding of principles discussed and with emphasis on chemical engineering applications. In addition to the text, the student will be exposed to classic and current literature in the field.
447. Liquid Crystal Optics
This course will introduce the student to the physical, chemical and optical properties of liquid crystals (LC) that are the basis for their wide and successful exploitation as optical materials for a broad variety of applications in optics, photonics and information display. Topics to be presented include: origins of LC physical properties in thermotropic and lyotropic materials as a function of chemical structure, influence of these structure-property relationships on macroscopic organization in LC mesophases, and the effect of molecular ordering and order parameter on properties of special significance for device applications. Operating principles for LC devices in a wide variety of applications will be described, including passive and tunable/switchable polarizers, wave plates, filters, information displays and electronic addressing, electronic paper, color-shifting polarizing pigments, optical modulators, and applications in photonics and lasers.

454. Interfacial Engineering
Prerequisite: CHE 225
Lectures on the fundamentals of colloids and interfaces, systems with high interfacial area, and their role in modern processes and products. Topics include interfacial tension, contact angle, adsorption, surfactants, miscelles, microemulsions, and colloidal dispersions. Techniques for formation and characterization of interfaces and colloids will be reviewed.

458. Electrochem & Engg & Fuel Cell
The course will concentrate on presenting the principles of electrochemistry and electrochemical engineering, and the design considerations for the development of fuel cells capable of satisfying the projected performance of an electric car. The course is expected to prepare you for the challenges of energy conversion and storage and the environment in the 21st century. Course is offered October 23 - December 11.

460. Solar Cells
This course will introduce students to the basics of photovoltaic devices: physics of semiconductors; pn junctions; Schottky barriers; processes governing carrier generation, transport and recombination; analysis of solar cell efficiency; crystalline and thin-film solar cells, tandem structures, dye-sensitized and organic solar cells. Students will learn about current photovoltaic technologies including manufacturing processes, and also the economics of solar cells as an alternative energy source. Critical analysis of recent advances and key publications will be a part of the course work.

464. Biofuels
This course will provide the student with a grounding in the fundamental principles of biofuels, including their sources, properties, and the biological processes by which they are made.

465. Sustainable Chem Processes
Prerequisite: Organic Chemistry I
Elements of sustainable chemical processes. Bulk and fine chemicals derived from renewable resources-- e.g. carbohydrates, animal fats, plant seeds, lignocellulose, algae, and carbon dioxide. Use of environmentally benign solvents-- e.g. ionic liquids, supercritical carbon dioxide, fluorous solvents, and liquid polymer-- for chemical reactions and separations. Chemical reactions activated by unconventional means-- e.g. ball milling, microwave heating, and ultrasound irradiation-- requiring minimum energy, catalysts, and solvents. Polymers produced with monomers from renewable resources, designed for recovery and recycling beyond intended service. Chemical and enzymatic catalysis enhanced by process integration to minimize the need for product separation and purification. Microreactor technologies to maximize rates of heat & mass transfer, chemical reaction rates, product yields and selectivity, in addition to facilitating process control, optimization, and scale-up.

469. Biotechnology & Bioengineering
The life science and engineering principles underlying biotechnology processes; established biotechnology processes including microbial and enzyme conversions, metabolic pathways, and fermentation kinetics; tools for biotechnology development including the recombinant DNA and monoclonal antibody techniques; emerging areas at the forefront of biotechnology, including immune technology and tissue and organ cultures.

472. Energy System Econ & Modeling
One of the goals for the course is to introduce basic economic principles and methodologies necessary to evaluate the economics of various energy options. Students will learn the basics of energy systems modeling using Powersim Modeling software. Students will also be introduced to various modeling tools from Sandia National Lab and National Renewable Energy Lab (NREL) for evaluating economics of energy options. Students should expect to have discussion about what it will take economically, technically, and politically to increase the role of renewable technologies into our energy systems.

476. Polymer Synthesis
Prerequisite: CHM 203
An introduction to polymerization reaction mechanisms. The kinetics of commercially relevant polymerizations are emphasized along with a discussion of important, contemporary polymerization schemes. Approaches to functionalize polymers and surface-initiated polymerizations will also be covered. An overview of polymer characterization techniques, emphasizing compositional analysis, will be presented. The course is intended for graduate students in Chemical Engineering, Chemistry, Materials Science, and Biomedical Engineering, but advanced undergraduates are welcome.
480. Chem of Advanced Materials
Preparation, structure, composition, and properties of advanced materials with emphasis on the underlying chemistry. Atomic structure and bonding of crystalline and amorphous solids and crystalline defect. Materials synthesis and processing by chemical and physical deposition methods. Focus on the relation of structure to properties of materials. Selected topics to illustrate the basic concepts and principles will include thin film materials, nanostructure/nanoscale/nanocomposite materials, and bulk materials.

482. Proc Microelec Device
This course features an overview of processes used in the fabrication of microelectronic devices, with emphasis on chemical engineering principles and methods of analysis. Modeling and processing of microelectronic devices. Includes introduction to physics and technology of solid state devices grade silicon, microfabrication, thermal processing, chemical vapor deposition, etching and ion implantation and damascene processing. Course is offered August 30 - October 18.

485. Thermodynamics & Stat Mech
Introduction to the topic: Thermodynamics and Statistical Mechanics. In the beginning macroscopic thermodynamics including phase equilibria and stability concepts will be covered followed by material related to the principles of statistical mechanics. Applications to various modern areas of the topic will be examined including the Monte Carlo simulation method, critical phenomena and diffusion in disordered media. The course will require completion of a project as well as regular homework assignments.

486. Polymer Physics
Prerequisites: organic chemistry, physical chemistry, fluid dynamics
Mechanisms and kinetics of polymerization reactions; solution, suspension, and emulsion polymerization processes; thermodynamics of polymer solutions; characterization by membrane osmometry, light scattering, viscometry, and size exclusion chromatography; polymer rheology including linear viscoelasticity; polymer morphology and phase transitions.

487. Surface Analysis

488. Intro to Energy Systems
A succinct, yet complete and critical introduction to the different means of producing energy.

890. Summer in Residence - MA

990. Summer in Residence

TEAM COMPUTER SCIENCE (TCS)

412. Human Computer Interaction
This course will explore the design, implementation, and evaluation of user interfaces. Students will study the theoretical methods for interface design and evaluation, including requirements gathering, usability heuristics, user interface inspections, usability studies, information visualization, and prototyping. Case studies of interface successes and failures will augment theory with practical experiences. Students will apply this methodology to assignments in the design, implementation, and evaluation cycle. Students taking this course at the graduate level will have additional readings and assignments.

440. Data Mining
Prerequisites: Prerequisites will be strictly enforced: CSC171, CSC 172 and MTH 161. Recommended: CSC 242 or CSC262; MTH165
Fundamental concepts and techniques of data mining, including data attributes, data visualization, data pre-processing, mining frequent patterns, association and correlation, classification methods, and cluster analysis. Advanced topics include outlier detection, stream mining, and social media data mining.

442. Artificial Intelligence

444. Logical Foundations of A.I.
Prerequisites: CSC 173 and CSC 242
An introduction to the logical foundations of AI, including first-order logic, search, knowledge representation, planning. Students taking this course at the 400 level will be required to complete additional readings and/or assignments, including a significant project or essay.

446. Machine Learning
Prerequisites: CSC 242 and MTH 165
This course presents the mathematical foundations of AI, including probability, decision theory and machine learning.

447. Natural Language Processing
Prerequisite: CSC 242
An introduction to natural language processing: constructing computer programs that understand natural language. Topics include parsing, semantic analysis, and knowledge representation.

Prerequisites: CSC 172 and CSC 242
An introduction to statistical natural language processing and automatic speech recognition techniques. This course presents the theory and practice behind the recently developed language processing technologies that enable applications such as speech-driven dictation systems, document search engines (e.g., finding web pages) and automatic machine translation. Students taking this course at the 400 level will be required to complete additional readings and/or assignments.
449. Machine Vision
Prerequisites: MTH 161 and CSC 242
Introduction to computer vision, including camera models, basic image processing, pattern and object recognition, and elements of human vision. Specific topics include geometric issues, statistical models, Hough transforms, color theory, texture, and optic flow. CSC 449, a graduate-level course, requires additional readings and assignments.

452. Computer Organization

Prerequisites: CSC 252 and CSC 254 are recommended. Familiarity with Python and C are beneficial but not strictly required.
This course explores unique aspects of dynamically-typed programming languages, which are now pervasive in domains such as scientific research, Web application development, gaming, and user interface design. The lessons you will learn here complement those in traditional compilers and programming languages courses, which focus mainly on statically-typed languages. We will use the Python language as a case study. In the first half of this course, we will study the internals of the Python interpreter, which is implemented in C. In the second half, we will build analysis and debugging tools for Python, potentially extending open-source tools with large user bases.

454. Prog Language Design & Imp.
Prerequisite: CSC 173; CSC 252 recommended
Design and implementation of programming languages, with an emphasis on imperative languages and on implementation tradeoffs. In-depth examination of “how programming languages work.” Topics include fundamental language concepts (names, values, types, abstraction, control flow); compilation and interpretation (syntactic and semantic analysis, code generation and optimization); major language paradigms (imperative, object-oriented, functional, logic-based, concurrent). Course projects include assignments in several different languages, with an emphasis on compilation issues.

455. Software Analysis & Improv
Prerequisite: CSC 254; CSC 252 recommended
Programming is the automation of information processing. Program analysis and transformation is the automation of programming itself—how much a program can understand and improve other programs. Because of the diversity and complexity of computer hardware, programmers increasingly depend on automation in compilers and other tools to deliver efficient and reliable software. This course combines fundamental principles and (hands-on) practical applications. Specific topics include data flow and dependence theories; static and dynamic program transformation including parallelization; memory and cache management; type checking and program verification; and performance analysis and modeling. The knowledge and practice will help students to become experts in software performance and correctness. Students taking the graduate level will have additional course requirements and a more difficult project.

456. Operating Systems
Prerequisite: CSC 252
Principles of operating system design, explored within the practical context of traditional, embedded, distributed, and real-time operating systems. Topics include device management, process management, scheduling, synchronization principles, memory management and virtual memory, file management and remote files, protection and security, fault tolerance, networks, and distributed computing. CSC 456, a graduate-level course, requires additional readings and assignments.

457. Computer Networks
Prerequisite: CSC 252

458. Parallel & Dist. Systems
Prerequisites: CSC 254, CSC 256 and consent of instructor
Principles of parallel and distributed systems, and the associated implementation and performance issues. Topics covered will include programming interfaces to parallel and distributed computing, interprocess communication, synchronization, and consistency models, fault tolerance and reliability, distributed process management, distributed file systems, multiprocessor architectures, parallel program optimization, and parallelizing compilers. Students taking this course at the 400 level will be required to complete additional readings and/or assignments.

459. Big Data Computer Systems

461. Database Systems
Prerequisites: Required: CSC 172; Recommended: CSC 173 and CSC 252.
This course presents the fundamental concepts of database design and use. It provides a study of data models, data description languages, and query facilities including relational algebra and SQL, data normalization, transactions and their properties, physical data organization and indexing, security issues and object databases. It also looks at the new trends in databases. The knowledge of the above topics will be applied in the design and implementation of a database application using a target database management system as part of a semester-long group project.

462. Comp Intro to Statistics
Prerequisite: MTH 161 & MTH 162 or EQUIVALENT
This course will cover foundational concepts in probability and statistical inference, with an emphasis on topics of interest to computer scientists. Following an introduction to elementary probability theory, topics will include applications of combinatorics; Markov chains; principles of statistical classification.
(Bayes’ rule, sensitivity and specificity, ROC curves) and random number generation. The theory of statistical estimation and hypothesis testing will be introduced, and applied to one and two sample inference for population means, proportions, variances and correlations. Nonparametric procedures will be discussed. Topics also include statistical modeling (ANOVA, simple and multiple regression), and computational methods. Students will be introduced to the R statistical computing environment.

465. Intermed Statistical Methods  
Prerequisite: CSC262 or equivalent

This course is a continuation of CSC262, covering intermediate statistical methodology and related computational methods, with an emphasis on the R statistical computing environment.

473. Comp Models of Music  
Prerequisites: Students should understand music notation and have knowledge of basic musical concepts such as key and meter.

We will explore various computational approaches to musical problems (rule-based approaches, connectionism, dynamical systems, and probabilistic models), focusing on two main areas: 1) models of musical processing and information retrieval; 2) models of musical styles. Our main focus will be on the symbolic level of music representation, though some attention will be given to signal-level processing. Most assignments will consist of reading articles and answering questions about them. There will be some programming assignments, with other options for students without programming ability.

478. Comp. Systems Security

481. Intro to Cryptography  
Prerequisites: (MTH 150 or MTH 162), AND (CSC 171 or prior programming experience)

The modern study of cryptography investigates techniques for facilitating interactions between distrustful entities. In this course we introduce some of the fundamental concepts of this study. Emphasis will be placed on the foundations of cryptography and in particular on precise definitions and proof techniques.

482. Design & Analysis Efficient Alg

483. Topics in Cryptography

This will be a seminar-style course in which students will read and present papers on current research in Cryptography. Potential topics include lattice-based cryptography, concurrency and protocol security, database privacy, cryptographic game theory and interplay of cryptography with other fields. The course will build on material covered in the introductory course (281/481) but is not a required prerequisite.

484. Advanced Algorithms  
Prerequisite: CSC 282

Advanced study of design and analysis of algorithms. Topics typically include: growth of functions; recurrences; probabilistic analysis and randomized algorithms; maximum flow; sorting networks; expander graphs; matrix operations; linear programming; discrete Fourier transform; number-theoretic algorithms; string matching; computational geometry; NP-completeness; approximation algorithms.

485. Algorithms & Elections  
Prerequisites: At least one of the following: MTH 150, MTH 143, MTH162, MTH172, PSC107, CSC280, CSC 281, CSC 282.

The focus of this course is on using algorithms to manipulate elections and on using complexity to protect elections from such manipulative attacks. Among the attacks we will study are manipulation, bribery and control. Students taking this course at the 400 level may be required to complete additional tests, readings, or assignments.

486. Computational Complexity  
Prerequisite: CSC 280

The difference between computable and uncomputable problems and between feasible and infeasible problems. Regarding the latter, what properties of a problem make it computationally simple? What properties of a problem may preclude its having efficient algorithms? How computationally hard are problems? Complete sets and low information content; P=NP; unambiguous computation and one-way functions; reductions relating the complexity of problems; complexity classes and hierarchies.

487. Algorithms and Elections  
Prerequisite: CSC280 OR CSC282

The focus of this course will be on using algorithms to attack elections and on using complexity to protect elections from manipulative attacks. Any student who has taken 280 or 282, or has a good understanding of NP-completeness, may take the course. Students taking this course at the 400 level may be required to complete additional tests, readings or assignments.

890. Summer in Residence - MA

990. Summer in Residence
401. Advncd Computer Architecture
Prerequisite: ECE 200 or equivalent

404. Multiprocessor Arch
Prerequisite: ECE 200
This course provides in-depth discussions of the design and implementation issues of multiprocessor system architecture. Topics include cache coherence, memory consistency, interconnect, their interplay and impact on the design of high-performance micro-architectures.

405. Mixed-Signal Ic Design
Prerequisites: ECE200, or ECE216, or ECE201/401. Familiarity with assembly language and C programming language. Instructor approval.
Review of complex embedded project development with Xilinx Virtex FPGA eval board and Xilinx CAD tools using Verilog HDL and C programming language. Embedded development and introduction to ethernet, USB, SATA, VGA, DVI, PS2, RS232, GPIO, and soft processor cores.

406. Intro to Parallel Comp Gpus
Prerequisites: ECE 200, or ECE 216, or ECE 201/401, or equivalent. Familiarity with assembly language and C programming language. Instructor approval.
GPU micro-architecture, including global memory, constant memory, texture memory, SP, SM, scratchpad memory, L1 and L2 cache memory, multi-ported memory, register file, and task scheduler. Parallel programming applications to parallel sorting, reduction, numeric iterations, fundamental graphics operations such as ray tracing. Desktop GPU programming using Nvidia's CUDA (Compute-Unified Device Architecture), CPU/GPU cooperative scheduling of partially serial/partially parallel tasks. No midterms or written exams. Course consists of seven hands-on projects using CUDA.

407. Adv GPU Project Dev
Prerequisite: ECE 206/406 or equivalent strongly recommended. Instructor approval.
Students develop an advanced project for the GPU platform. A GPU compute-cluster can be employed, as well as a single GPU computer. Students meet with the instructor twice a week to report the progress and the new direction is determined based on the results and the ongoing progress. Project options include: Protein folding (BLAST algorithm), Face recognition (using Open CV), 3D Image reconstruction of biomedical images, and other sophisticated image processing algorithms.

420. Intro to Solid State
Prerequisite: ECE 221
Basic theory and phenomena of solid state physics, with applications to metals, semiconductors, magnetic materials, and superconductors.

423. Semiconductor Devices
Prerequisites: ECE221, ECE230, PHY123 or permission of instructor

427. Electric Power: Conversion, Transmission, and Consumption
Prerequisites: Enrollment will be restricted to seniors and graduate students who possess some background in either thermodynamics or AC circuits.
We will describe how the principal sources of energy - coal, natural gas, impounded water (hydroelectric), and fission materials - are exploited to create electric power, how it is transmitted and distributed through the grid and finally the patterns of its consumption. To assure that students gain a proper appreciation for the factors that determine the real cost of electricity per kilowatt-hour, the subject will be treated in a highly quantitative way. The goal will be to provide students with the information and tools they need for informed analysis of the true prospects and technological challenges involved in integration of new energy sources, such as solar, wind, geothermal, and tidal power, with the existing grid. There will be weekly homework and a midterm. Two projects with oral presentations, including a major one at the end of the semester, are required. There is no final exam. Several required field trips to local power facilities occur during the semester.

432. Acoustical Waves
Prerequisites: MTH 164 and PHY 121
Acoustic wave equation; plane, spherical, and cylindrical wave propagation; reflection and transmission at boundaries; normal modes; absorption and dispersion; radiation from points, spheres, cylinders, pistons, and arrays; diffraction; nonlinear acoustics.

433. Musical Acoustics
Prerequisites: MTH 165, MTH 164, and PHY 121 or equivalents.
Aspects of acoustics. Review of oscillators, vibratory motion, the acoustics wave equation, reflection and transmission, and radiation and reception of acoustic waves. Resonators, hearing and speech, architectural and environmental acoustics.
434. Microelectromechanical Systems  
Prerequisites: MTH163, MTH164, PHY122 (or equivalents)  

435. Intro to Opto-Electronics  
Prerequisites: ECE230 and ECE221 equivalent or permission of instructor.  
Introduction to fundamentals of wave propagation in materials, waveguides and fibers, generation, modulation, and detection of light using semiconductor devices, and elements of optocommunication systems.

436. Nanophot/Nanomech Devices  
Prerequisites: ECE 230 or 235, OPT 262 or 462, or 468, or 223, or 412; PHY 237, or 407  
Various types of typical nanophotonic structures and nanomechanical structures, fundamental optical and mechanical properties: micro/nano-resonators, photonic crystals, plasmonic structures, metamaterials, nano-optomechanical structures. Cavity nonlinearoptics, cavity quantum optics, and cavity optomechanics. Fundamental physics and applications, state-of-art devices and current research trends. This class is designed primarily for graduate students. It may be suitable for senior undergraduates if they have required basic knowledge.

440. Intro to Random Processes  
Prerequisite: ECE242 or equivalent  
The goal of this course is to learn how to model, analyze and simulate stochastic systems, found at the core of a number of disciplines in engineering, for example communication systems, stock options pricing and machine learning. This course is divided into five thematic blocks: Introduction, Probability review, Markov chains, Continuous-time Markov chains, and Gaussian, Markov and stationary random processes.

441. Detection Estimation Theory  
Prerequisites: ECE440, ECE446 or equivalents, or permission of the instructor  

444. Digital Communications  
Prerequisite: ECE 242 or permission of Instructor  
Digital communication system elements, characterization and representation of communication signals and systems. Digital transmission, binary and M-ary modulation schemes, demodulation and detection, coherent and incoherent demodulators, error performance. Channel capacity, mutual information, simple discrete channels and the AWGN channel. Basics of channel coding and error correction codes.

445. Wireless Communications  
Prerequisite: ECE 242 or equivalent or instructor permission  
This course teaches the underlying concepts behind traditional cellular radio and wireless data networks as well as design tradeoffs among RF bandwidth, transmitter and receiver power and cost, and system performance. Topics include channel modeling, digital modulation, channel coding, network architectures, medium access control, routing, cellular networks, WiFi/IEEE 802.11 networks, mobile ad hoc networks, sensor networks and smart grids. Issues such as quality of service (QoS), energy conservation, reliability and mobility management are discussed. Students are required to complete a semester-long research project in order to obtain in-depth experience with a specific area of wireless communication and networking.

446. Digital Signal Processing  
Prerequisites: ECE 241 and math programming skills  
Analysis and design of discrete-time signals and systems, including difference equations, discrete-time filtering, z-transforms, A/D and D/A conversions, multi-rate signal processing, FIR and IIR filter design, the Discrete Fourier Transform (DFT), circular convolution, Fast Fourier Transform (FFT) algorithms, windowing, and classical spectral analysis.

447. Digital Imaging Processing  
Prerequisites: ECE242 and ECE440 & 446 are recommended or permission of instructor  
1. Introduction to Python programming language, 2. Intensity transformation and spatial filtering (basic intensity transformation functions, histogram processing, fundamental of spatial filtering, smoothing filters, sharpening filters 3. Filtering the frequency domain (Sampling and the Fourier transform, discrete Fourier transform of one and two variables, image smoothing using frequency domain filters, Image Sharpening using Fourier domain filters) 4. Image restoration and reconstruction (restoration in the presence of noise, periodic noise reduction by frequency domain filtering, estimating degradation function, inverse filtering, constrained least squares filtering, image reconstruction from projections) 5. Image compression, 6. Morphological image processing (erosion and dilation, Gray-scale morphology) 7. Image segmentation (thresholding, region based segmentation, morphology watersheds), 8. Image registration
448. Wireless Sensor Networks
This course will cover the latest research in the area of Wireless Sensor Networks. We will cover all aspects of these unique and important systems, from the hardware and radio architecture through protocols and software to applications. Topics will include sensor network architectures, hardware platforms, physical layer techniques, medium access control, routing, topology control, quality of service (QoS) management, localization, time synchronization, security, storage, and other advanced topics. Each student must complete a semester-long course related to wireless sensor networks.

450. Information Theory
Prerequisites: MTH 201, or permission of Instructor
Entropy, Relative Entropy, mutual information, asymptotic equipartition property, data compression, channel capacity, joint source channel coding theorem, Gaussian channels, rate distortion theory, selected applications.

452. Med Imaging-Theory & Implemt
Prerequisite: ECE242
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Fourier transform relations and reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI.

453. Dynamic Systems & Control
Prerequisites: MTH 163, MTH 164, MTH 165, ECE 241
Dynamic systems and linear control. The course emphasizes a state space approach. Topics covered include state-space models, modes, stability, controllability, observability, transfer function matrices, poles and zeros, and state feedback.

461. Intro to VLSI
Prerequisites: ECE 112 and ECE 221
Introduction to high performance integrated circuit design. Semiconductor technologies, CMOS inverter. General background on CMOS circuits, ranging from the inverter to more complex logical and sequential circuits. The focus is to provide background and insight into some of the most active high performance related issues in the field of high performance integrated circuit design methodologies, such as CMOS delay and modeling, timing and signal delay analysis, low power CMOS design and analysis, optimal transistor sizing and buffer tapering, pipelining and register allocation, synchronization and clock distribution, retiming, interconnect delay, dynamic CMOS design techniques, power delivery, on-chip regulators, 3-D technology and circuit design, asynchronous vs. synchronous tradeoffs, clock distribution networks, low power design, and CMOS power dissipation.

462. Advanced Cmos VLSI Design
Prerequisite: ECE261 or ECE222
Senior design course for “Computer Design” or “Integrated Electronics” concentrations. Review of CMOS Subsystem design. Design focus on digital or mixed-signal systems, such as a simple microprocessor, a self-timed multiplier, a digital filter, data converter, or memory. Project design requirements include architectural design, logic and timing verification, layout design, and test pattern generation. Extensive use of CAD tools. The resulting VLSI chips may be fabricated.

463. VLSI Error Control Sys
Prerequisites: Graduate standing or permission of Instructor
This course reviews the reliability challenges introduced by the multi-core billion-transistor integration era, and discusses circuit, architectural, and algorithm level solutions to address these challenges. After a brief review of IC design and layout concepts, students are introduced to the tradeoffs in continued CMOS scaling. Lectures, assigned readings, discussions, student presentations, review reports of the research literature, computer simulations and modeling, design projects of varying complexity, and a final scholarly paper required.

464. Fundamentals of VLSI Testing

465. Perf Issues Vls/Ic
Prerequisite: [A] Instructor’s permission required
Primary and recent research in the fields of high performance digital and analog VLSI design and analysis. Provides background and insight into some of the more active performance related research topics of the field such as CMOS design techniques, speed/area/power tradeoffs in CMOS circuits, low power design, RLC interconnect, synchronization and clock distribution, pipelining/retiming, and many other areas.

466. Rf and Microwave Integrated Circuits
Prerequisites: ECE222, ECE230 or equivalent. Permission of instructor
This course involves the analysis and design of radio-frequency (RF) and microwave integrated circuits at the transistor level. We begin with a review of electromagnetics and transmission line theory. Several design concepts and techniques are then introduced, including Smith chart, s-parameters, and EM simulation. After the discussion of RLC circuits, high-frequency narrow-band amplifiers are studied, followed by broadband amplifiers. Then we examine the important issue of noise with the design example of low-noise amplifiers (LNA). Nonlinear circuits are studied next with the examples of mixers. A study of oscillators and phase noise follows. Afterwards we introduce phase-locked loops (PLL) and frequency synthesizers. The course concludes with an overview of transceivers architectures. The course emphasizes the development of both circuit design intuition and analytical skills. There are bi-weekly design labs and a term project using industry-standard EDA tools (ADS, Asitic, etc.).

467. Analog Integrated Circuit
Prerequisites: ECE113, ECE221
Analysis and design of analog CMOS integrated circuits. MOS and bipolar device structures and models. Modern opamp design with noise, offset and distortion analysis, feedback, frequency
468. Advanced Analog CMOS Circuits and Systems
Prerequisites: ECE113, ECE221, ECE222, ECE246/446, ECE 467

469. High Speed Integrated Elect
Prerequisites: ECE222 and ECE230
Integrated electronics in high speed and wideband applications, which spans the fields of wireless communications, computing, fiber optics, and instrumentation. High speed semiconductor technologies (CMOS, SiGe, SOI, GaAs, InP, etc) and devices (MOSFET, MESFET, HEMT, HBT, and tunneling diodes), design of high speed phase locked and delay-locked loops (PLL and DLL). VCO, frequency divider, phase detector, and loop filter.

471. Comp Models of Music Proc
This course is designed for engineering and science students to learn the basic elements of music theory and analysis, but employing concepts and tools from digital signal processing, pattern classification, machine learning and data mining. Class requirements include weekly readings and programming assignments, and a final project in which students complete an analysis of a large-scale symphonic work combining their subjective aesthetic response to the piece with the computational analysis using the tools developed throughout the course.

472. Audio Signal Proc
Prerequisites: ECE 114 and basic Matlab programming, ECE 241 or other equivalent signals and systems courses.
This course is a survey of audio digital signal processing fundamentals and applications. Topics include sampling and quantization, analog to digital converters, time and frequency domains, spectral analysis, vocoding, digital filters, audio effects, music audio analysis and synthesis, and other advanced topics in audio signal processing. Implementation of algorithms using Matlab and on dedicated DSP platforms is emphasized.

475. Audio Software Design
Prerequisite: ECE114 or instructor permission
This course aims to give students the ability to develop their own audio/music programs in C and a few major open-source audio programming languages. It begins with an introduction to computer music and audio programming, and a comparative survey of audio programming languages. After an overview of the C language, we then explore the topics of programming for sound synthesis. The second half of this course introduces the primary techniques of sound design using the audio programming environments of Pure Data and CSound. Students will practice their programming techniques through a series of programming assignments and a final project.

476. Audio Software Des II
Prerequisites: AME 262, ECE 475 or Instructor Permission.
This course is a sequel to AME 262/ECE 475/TEE 475 Audio Software Design I. The first part of the course will explore designing audio plug-ins with Faust (Function AUdio STream), which is a high-level functional programming language designed for real-time audio digital signal processing (DSP) and sound synthesis. Students will learn how to design plug-ins for Pro Tools, Logic and other digital audio workstations (DAWs). The second part of the course will focus on audio programming for iOS apps in Swift, which is the new programming language for iOS and OS X. Students will learn how to make musical apps with the sound engine libpd, which turns Pure Data (Pd) into an embeddable library. A special topic will introduce audio programming for video games with Wwise and FMOD.

477. Computer Audition
Prerequisites: ECE 246/446 or ECE 272/472 or other equivalent signal processing courses, and Matlab programming. Knowledge of machine learning techniques such as Markov models, support vector machines is also helpful, but not required.
Computer audition is the study of how to design a computational system that can analyze and process auditory scenes. Problems in this field include source separation (splitting audio mixtures into individual source tracks), pitch estimation (estimating the pitches played by each instrument), streaming (finding which sounds belong to a single event/source), source localization (finding where the sound comes from) and source identification (labeling a sound source).

479. Audio Recording - Technology and Fundamentals
Prerequisite: Instructor’s permission required
This course covers the acoustical and psychoacoustic fundamentals of audio recording including the nature of sound, sound pressure level, frequency and pitch, hearing and sound perception, reflection, absorption and diffusion of sound, sound diffraction, room acoustics, reverberation, and studio design principles. The course also provides practical experience in audio recording including an introduction to recording studio equipment, microphones and microphone placement techniques, signal flow, amplification, analog and digital recording, analog to digital conversion, digital processing of sound, multi-track recording and an introduction to mixing and mastering. Each student is required to complete a substantive recording project at the end of the course.
520. Spin Based Electronics  
**Prerequisite:** Permission of Instructor & familiarity with elementary quantum mechanics  
Up until now CMOS scaling has given us a remarkable ride with little concern for fundamental limits. It has scaled multiple generations in feature size and in speed while keeping the same power densities. However, CMOS finally encounters fundamental limits. The course is intended for students interested in research frontiers of future electronics technologies. The course begins with introduction to the basic physics of magnetism and of quantum mechanical spin. Then it covers aspects of spin transport with emphasis on spin-diffusion in semiconductors. The second part of the course is comprised of student and lecturer presentations of selected spintronics topics which may include: spin transistors, magnetic random access memories, spin-based logic paradigms, spin-based lasers and light emitting diodes, magnetic semiconductors, spin-torque devices for memory applications and the spin Hall effect.

590. Energy for 21st Century: surv  
890. Summer in Residence - MA  
990. Summer in Residence  

**TEAM MECHANICAL ENGINEERING (TME)**

407. Dynamical Systems  
**Prerequisites:** ME 121, 211, 213; ME/MTH 163. ME 201 or higher strongly recommended  

408. Phase Transformation  
**Prerequisite:** ME 280 or equivalent  
How and why atomic rearrangements leading to phase transformations occur and how they are associated with kinetic and crystallographic features; liquid-solid and solid-solid transformations, nucleation theory, growth, massive and martensitic transformations.

424. Introduction to Robust Design & Quality Engineering  
**Prerequisite:** ME 164 or Equivalent  
Definition and pursuit of “quality” as a design criterion. The concept of robust design. Selection of the quality characteristic, incorporation of noise, and experimental design to improve robustness. Analysis and interpretation of results.

432. Opto-Mechanical  
The mechanical design and analysis of optical components and systems will be studied. Topics will include kinematic mounting of optical elements, the analysis of adhesive bonds, and the influence of environmental effects such as gravity, temperature, and vibration on the performance of optical systems. Additional topics include analysis of adaptive optics, the design of lightweight mirrors, thermo-optic and stress-optic (stress birefringence) effects. Emphasis will be placed on integrated analysis which includes the data transfer between optical design codes and mechanical FEA codes. A term project is required for ME 432.

434. Intro to Plasma Physics I  
**Prerequisite:** PHY 217 or OPT 262  

435. Intro to Plasma Physics II  
**Prerequisite:** ME 434 or consent of the instructor  

436. Compressible Flow  
**Prerequisites:** ME 225 and ME 201 or MTH 281  
Kinematics, equations of motion; thermodynamics of gases; linear acoustics; Bernoulli equation; potential flow; steady one-dimensional flow; shock waves, normal and oblique shocks; unsteady one-dimensional flow, characteristics. Applications in engineering and astrophysics.

437. Incompressible Flow  
**Prerequisites:** ME 225, ME 201 or MTH 281  
The study of incompressible flow covers fluid motions which are gentle enough that the density of the fluid changes little or none. Topics: Conservation equations. Bernoulli’s equation, the Navier-Stokes equations. Inviscid flows; vorticity; potential flows; stream functions; complex potentials. Viscosity and Reynolds number; some exact solutions with viscosity; boundary layers; low Reynolds number flows. Waves.

440. Structural Mechanics  
**Prerequisites:** ME 226, ME 213  
Application of energy methods to obtain the governing equations and approximate solutions to problems involving elastic structures. Static models will be developed to determine the maximum displacements and stresses for structures subjected to forces. Dynamic models will be developed to determine approximate natural frequencies and mode shapes. Rayleigh-Ritz and Galerkin approximation methods will be covered.
441. Finite Elements
Prerequisites: ME 226 and ability to program in MATLAB.
This course provides a thorough grounding on the theory and application of linear steady-state finite element method (FEM) applied to solid mechanics. Topics include: review of matrix algebra and solid mechanics, Principle of Minimum Potential Energy, Rayleigh Ritz Method, FEM computational procedures, isoparametric shape functions and numerical integration for 1D, 2D, and 3D elements, error estimation and convergence, and the demonstration of FEM best practices using a commercial FEM code. A semester project that involves coding FEM software in Matlab is required for graduate students.

443. Applied Vibration Analysis
Prerequisites: ME 226, ME213
Deformations and the stresses in different types of structural systems subjected to prescribed dynamic loading conditions. Topics include: overview of structural dynamics, matrix structural analysis and Finite Element analysis, single-degree and multi-degree-of-freedom systems, linear and inelastic systems, numerical evaluation of dynamic response, Finite Element methods in dynamic analysis, earthquake response and structural design.

444. Continuum Mechanics
Prerequisites: Basic ordinary and partial differential equations, linear algebra, undergraduate fluid mechanics (ME225) and solid mechanics (ME226).

445. Precision Instrument Design
This course focuses teaching the multidisciplinary aspects of designing complex, precise systems. In these systems, aspects from mechanics, optics, electronics, design for manufacturing/assembly, and metrology/qualification must all be considered to design, build, and demonstrate a successful precision system. The goal of this class is to develop a fundamental understanding of multidisciplinary design for designing the next generation of advanced instrumentation. This course is open to graduate students in engineering and physics backgrounds although it has a strong emphasis on mechanical engineering and systems engineering topics. This course is open to undergraduates who are in their senior year.

449. Elasticity
Prerequisite: ME226; ME163 or MTH163
Analysis of stress and strain; equilibrium; compatibility; elastic stress-strain relations; material symmetries. Torsion and bending of bars. Plane stress and plane strain; stress functions. Applications to half-plane and half-space problems; wedges; notches. 3-D problems via potentials.

453. Intro to Nuclear Engineering
Prerequisites: MTH 163, Ordinary Differential Equations, or equivalent ME 122, Computational Methods in Mechanical Engineering, or equivalent PHY 123, Modern Physics (recommended)
A first course in nuclear engineering with emphasis on the fundamental physics and technology of modern water-cooled power reactors, the nuclear fuel cycle, and the regulatory environment surrounding nuclear power in the United States.

458. Non-Linear Finite Elements
Prerequisite: ME441 or permission of instructor.
The theory and application of nonlinear FE methods in solid and structural mechanics, and biomechanics. Topics: review and generalization of linear FE concepts, review of solid mechanics, nonlinear incremental analysis, FE formulations for large displacements and large strains, nonlinear constitutive relations, incompressibility and contact conditions, hyperelastic materials, damage plasticity formulation, solution methods, explicit dynamic formulation.

460. Thermodynamics of Solids
Review of basic thermodynamic quantities and laws; equations of state; statistical mechanics; heat capacity; relations between physical properties; Jacobian algebra; phase transformations, phase diagrams and chemical reactions; partial molal and excess quantities, phases of variable composition; free energy of binary and multicomponent systems; surfaces and interfaces. The emphasis is on the physical and chemical properties of micro and nano solids including stress and strain variables.

461. Fracture & Adhesion
Prerequisites: ME 280, 226
Stress fields near cracks in linear elasticity. Linear elastic fracture mechanics. Griffith fracture theory. K and J approaches to fracture. Failure analysis and fracture stability; crack tip deformation, crack tip shielding. Crack nucleation. Adhesion. Low cycle fatigue; fatigue crack propagation. Emphasis on the role of microstructure in determining fracture, adhesion and fatigue behavior of materials; improving fracture toughness for advanced materials especially ceramics and polymers. This course is taught at a level that brings the student to the level of current research.

462. Solids & Materials Lab
Prerequisites: ME280, ME226, MTH161, 162 and CHM 131
In this course, you will apply previously learned theoretical concepts to practical problems and applications. In addition, you will learn experimental techniques and enhance your technical writing skills. This course has two parts, a series of small laboratory exercises and a project. During the semester, students will work in groups of three to complete the assigned work, labs, and reports. The lab section of the course is designed to present basic applied concepts that will be useful to a broad base of engineering problems. The project portion is where you will work on a more specific idea, tailored around your desired future goals.
463. Microstructure
Prerequisite: ME 280


466. Corrosion

A scientific approach to understanding the oxidation and dissolution of metals related to corrosion control, electrical energy generation, metallic plating, and energy storage. Characterization of corrosion types. Interfacial electrochemical mechanisms, thermodynamics, electrode potentials, interphases, and Pourbaix diagrams. Kinetics of free corrosion and electron limited corrosion including polarizations and overpotentials. Tafel behavior with Butler-Volmer interpretations. Experimental measurements used in corrosion research and in battery research. Corrosion in iron based and aluminum based aqueous systems. Corrosion in lithium and sodium based non-aqueous systems. Effects of stress, including mechanisms of stress corrosion cracking related to metallurgical structure and role of the electrical double layer. Catalytic behavior of free surface nanostructures intended to catalyze oxygen reactions and ease barriers to metallic plating and ionic dissolution at polar electrolyte interfaces.

481. Mechanical Behavior of Solids
Prerequisite: ME 280, MTH 163 or equivalent

Description: The mechanical response of crystalline (metals, ceramics, semiconductors) and amorphous solids (glasses, polymers) and their composites in terms of the relationships between stress, strain, damage, fracture, strain-rate, temperature, and microstructure. Topics include: (1) Material structure and property overview. (2) Isotropic and anisotropic elasticity and viscoelasticity. (3) Properties of composites. (4) Plasticity. (5) Point and line defects. (6) Interfacial and volumetric defects. (7) Yield surfaces and flow rules in plasticity of polycrystals and single crystals. (8) Macro and micro aspects of fractures in metals, ceramics and polymers. (9) Creep and superplasticity. (10) Deformation and fracture mechanism maps. (11) Fatigue damage and failure: fracture and failure in composites (if time permits).

483. Biosolid Mechanics
Prerequisites: ME 226, BME 201 & 201L (or ME 120)

Application of engineering mechanics to biological tissues including bone, soft tissue, cell membranes, and muscle. Realistic modeling of biological structures, including musculoskeletal joints and tissues. Experimental methods, computational examples and and material models. Investigations of the responses of biological tissues to mechanic factors.

535. Laser Plasma Interactions


536. Inertial Confinement Fusion

Prerequisite: Undergraduate Quantum Mechanics

Interaction of light with materials’ electrons, phonons, plasmons, and polaritons. Optical reflection, refraction, absorption, scattering, Raman scattering (spontaneous and stimulated), light emission (spontaneous and stimulated). Electrooptic effects and optical nonlinearities in solids. Plasmonics. Semiconductors and their nanostructures are emphasized; metals and insulators also discussed.

890. Summer in Residence - MA

TEAM OPTICS (TEO)

412. Quantum Mechanics - Optics

Quantum theory topics relevant to atomic physics, radiation theory and quantum optics.

421. Opt Properties of Materials
Prerequisite: Undergraduate Quantum Mechanics

Fundamentals and applications of laser systems, including optical amplification, cavity design, beam propagation and modulation.

424. Fundamentals of Lasers
Prerequisites: Knowledge of simple quantum mechanics and scalar diffraction theory is assumed. OPT 241 and OPT 261, MTH 163 is recommended.

Fundamentals and applications of laser systems, including optical amplifier, cavity design, beam propagation and modulation.

425. Radiation & Detectors

The course covers the following topics: emission of thermal radiation, modeling of optical propagation (radiometry), quantifying the human perception of brightness (photometry) and of color (colorimetry), fundamentals of noise in detection systems, parameters for specifying the performance of optical detectors, and a survey of several specific types of detectors. References: Boyd, Radiometry and the Detection of Optical Radiation; Kingston, Detection of Optical and Infrared Radiation.

428. Optical Commun Systems

Covers analog and digital signals, multiplexing techniques, modulation formats, dispersive and nonlinear properties in optical fibers, LED’s and semiconductor lasers, optical amplifiers and dispersion management with several systems.
432. Opto-Mechanical

The mechanical design and analysis of optical components and systems will be studied. Topics will include kinematic mounting of optical elements, the analysis of adhesive bonds, and the influence of environmental effects such as gravity, temperature, and vibration on the performance of optical systems. Additional topics include analysis of adaptive optics, the design of lightweight mirrors, thermo-optic and stress-optic (stress birefringence) effects. Emphasis will be placed on integrated analysis which includes the data transfer between optical design codes and mechanical FEA codes. A term project is required for the course.

433. Opt Fab and Testing Tech

You will be given a first-hand working knowledge of optical glasses, their properties, and the methods for specifying, manufacturing and testing high quality optical components. Lectures emphasize the optical and physical properties of glass, and how these influence the grinding and polishing process. Conventional fixed/loose abrasive grinding and pitch polishing are examined. New concepts for optical manufacturing are covered. The meaning of specifications will be reviewed. The laboratory portion of the course exposes you to abrasive grits, slurries, pitch polishing and the vagarious nature of the conventional polishing process, under the guidance of a master optician. Glass types and part shapes are assigned to illustrate the degree of difficulty required to achieve optical quality surfaces with hand and machine operations. In-process metrology is performed with a variety of instruments.

441. Geometrical Optics

This course is designed to give the student a basic working knowledge of image-forming optical systems. The course is oriented towards problem solving. Material covered includes: image formation, raytracing and first-order properties of systems; magnification, F/number, and numerical aperture; stops and pupils, telecentricity vignetting; telescopes, microscopes, magnifiers, and projection systems; the Delano diagram; the eye and visual systems, field lenses; optical glasses, the chromatic aberrations, and their correction; derivation of the monochromatic wavefront aberrations and study of their effects upon the image; third order properties of systems of thin lenses; effects of stop position and lens bending; aplanatic, image centered, and pupil centered surfaces; and field flatteners. References: Smith, Modern Optical Engineering, McGraw-Hill; Lecture notes.

442. Instrumental Optics

Prerequisite: OPT 441

This course provides an in-depth understanding of the principles and practices of optical instrumentation: Optical metrology, including wavefront and surface metrology, interferometric instruments and interferogram analysis, coherence and coherence-based instruments, phase measurement and phase-shifting interferometry; spectroscopic instrumentation, including the Fourier transform spectrometer, the Fabry-Perot interferometer, and the grating monochromator; image plane characterization (star test, Ronchi test, and modulation transfer function); the influence of illumination and partial coherence on image forming systems, including microscopes, systems for projection lithography, and displays.

443. Found of Modern Opt Sys

This course covers fundamental ray optics that are necessary to understand today’s simple to advanced optical systems. Included will be paraxial optics, first-order optical system design, illumination, optical glasses, chromatic effects, and an introduction to aberrations. References: Hecht, Optics (4th edition); Smith, Modern Optical Engineering; Lecture notes.

444. Lens Design


446. Optical Thin Film Coatings

Prerequisite: OPT 262

Optical interference in a multilayer stack and its application to anti-reflection coatings, beamsplitters, laser mirrors, polarizers, and bandpass filters.

447. Liquid-Crystal Materials and Optical Applications

This course will introduce the student to the physical, chemical and optical properties of liquid crystals (LC) that are the basis for their wide and successful exploitation as optical materials for a broad variety of applications in optics, photonics and information display. Topics to be presented include: origins of LC physical properties in thermotropic and lyotropic materials as a function of chemical structure, influence of these structure-property relationships on macroscopic organization in LC mesophases, and the effect of molecular ordering and order parameter on properties of special significance for device applications. Operating principles for LC devices in a wide variety of applications will be described, including passive and tunable/switchable polarizers, wave plates, filters, information displays and electronic addressing, electronic paper, color-shifting polarizing pigments, optical modulators, and applications in photonics and lasers.
448. Vision and the Eye
How the human eye's optical and neural factors process color and spatial information includes comparison with the design and capabilities of other animals' eyes.

450. Polarization
The physics and engineering of polarized light, including polarization ray tracing and polarization in high numerical aperture focusing.

452. Med Imaging-Theory & Implemt
Prerequisite: ECE242
Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Special attention given to the Fourier transform relations and reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI.

461. Fourier Optics
Prerequisites: Undergraduate electromagnetic theory, advanced calculus, linear algebra.
The principles of physical optics including diffraction and propagation based on Fourier transform theory; integral formulation of electromagnetic propagation; diffraction from apertures and scattering objects; applications to optics of Fourier transform theory, sampling expansions, impulse response, propagation through optical systems, imaging and transforming, optical transfer function, optical filtering; and selected topics of current research interest. Text: Goodman, Introduction of Fourier Optics; Class Notes; References: Born and Wolf, Principles of Optics; Gaskill, Linear Systems, Fourier Transforms and Optics; Papoulis, Systems and Transforms with Applications in Optics; Siegman, Lasers.

462. Electromagnetism of Waves
Electromagnetic theory as a foundation for classical descriptions of many optical phenomena. Pertaining topics reviewed and expanded upon.

463. Wave Optics & Imaging
Prerequisites: Advanced Calculus, Linear Algebra
This course provides the practicing optical engineer with the basic concepts of interference, diffraction, and imaging. Each topic will be reinforced with real-world examples. The interference section will include interferometry, Fabry-Perot etalons, and multilayer thin films. The diffraction and imaging sections will include, but are not limited to, diffractive optics, continuous and discrete Fourier transforms, convolution theory, and Linear Systems. References: Hecht, Optics (4th edition); Goodman, Introduction to Fourier Optics; Lecture notes.

465. Principles of Lasers
Topics include quantum mechanical treatments to two-level atomic systems, optical gain, homogeneous and inhomogeneous broadening, laser resonators, cavity design, pumping schemes, rate equations, Q-switching for various lasers.

467. Non-Linear Optics
Prerequisite: OPT 461 or OPT 462

468. Integrated Photonics

476. Biomedical Optics
Biomedical spectroscopy (absorption, fluorescence, Raman, elastic scattering); propagation of photons in highly scattering media (such as tissue); techniques for high-resolution imaging in biological media: confocal imaging, multiphoton imaging and optical coherence tomography. Taught every other fall.

511. Adv Math Methods in Optics

890. Summer in Residence - MA

990. Summer in Residence

TECHNICAL ENTREPRENEURSHIP MANAGEMENT (TEM)

401. Economics, Marketing and Strategy Primer for Entrepreneurs
This course presents fundamental concepts of microeconomics, marketing, and strategy to provide a foundation for understanding the economic marketplace and for identifying and assessing entrepreneurial opportunities. We begin with the study of consumer and firm behavior and the resulting demand and supply conditions in markets for goods and services. Using equilibrium analysis, we then investigate the determinants of market structure, prices, output levels, firm profitability, and consumer welfare when firms and consumers interact in the marketplace. Building on the economic model, we explore marketing issues, in particular the value proposition for new products and strategies for market entry, distribution, pricing and product positioning. Additional strategy topics include game theory and its managerial implications, incentive conflicts and contracts, and the relationship between government regulation and the business environment. (Fall)

402. Accounting and Finance Primer for Entrepreneurs
This course is designed to present the fundamentals of financial accounting and analysis to enable participants to understand and use the principles of finance and accounting information to better structure business decisions. The accounting module will present skills required to interpret and analyze common financial statements, and evaluate a company's past and potential
future performance. Topics of discussion will include transaction analysis, cash vs. accrual accounting, financial statements and analysis, development of budgets and pro-forma statements, and depreciation and inventory methodologies. The financial module will present skills required to understand how companies make investment and financing decisions. Topics of discussion will include net present values, an intro to financial instruments, the tradeoff between risk and return in financial markets, capital budgeting and investment decision-making, choosing a capital structure, and using the weighted average cost of capital. (Fall)

411. Gen Managemnt of New Venture
This course provides an opportunity to examine the management practices associated with technical innovation and new business development. The analysis of entrepreneurship is evaluated primarily from the perspective of a start-up venture that requires equity capital investment. Management issues discussed include organizational development, analysis of market opportunities, market engagement, financial planning and control, capitalization, sources of funds, the due-diligence process and valuing the venture. Teams of three to four students will collaborate in the preparation of a business plan. The course will include time for students to share business ideas and identify possible team members. Each team will have a coach who is an experienced businessperson. The coach will be available to provide feedback to the team.

440. Screening Tech Opportunities
This course provides a process used to quickly assess the commercial merits of raw technologies. This course focuses on the very earliest stage of concepts where information is greatly lacking and the time and money to research such answers is also limited. Students, in group format, will select and “thicken” two technologies of interest. Thickening will involve a cursory evaluation based upon technical merit, early market indicators, human resource availability, and business challenges. Teams will use a template to present the results of their investigation to a panel. Teams must state whether or not each technology is worthy to bring forward into TEM 441 and TEM 411. (Fall)

441. Product Dev & Tech Mgmt
In this class we will explore system engineering via the ISO9000 product development process and will illustrate how to use this process to develop both products and research systems that meet necessary specifications. The first eight weeks emphasize system integration including the development of the product development plans, partitioning of a system into subsystems, quantitative analysis of system performance and the role of prototypes. The second half of the semester emphasizes the planning needed to take systems to manufacture. During the course the students will prepare a product development plan on a project that was selected during TEM 440 Screening Technical Opportunities. The course is intended to be interactive. A portion of the classes will be dedicated to “brain-storming” solutions to technical problems and formal design reviews where the students will review the project plans of other students.

491. Master’s Reading
492. Energy System Econ & Modeling
One of the goals for the course is to introduce basic economic principles and methodologies necessary to evaluate the economics of various energy options. Students will learn the basics of energy systems modeling using Powersim Modeling software. Students will also be introduced to various modeling tools from Sandia National Lab and National Renewable Energy Lab (NREL) for evaluating economics of energy options. Students should expect to have discussion about what it will take economically, technically, and politically to increase the role of renewable technologies into our energy systems.

494. Internship
494P. Internship
890. Summer in Residence - MA
897. Master’s Dissertation
897A. Masters Dissertatn Absentia
899. Master’s Dissertation
990. Summer in Residence

ENTREPRENEURSHIP ELECTIVES
Students who wish to bolster their business background can choose an entrepreneurship elective. Students choosing to pursue this option take a graduate-level business course offered by the Simon Business School. This is a unique opportunity for students to further immerse themselves in business curriculum all while taking courses with Simon School graduate students. Kathy Driscoll advises TEAM students on course selection to help students register for a course tailored to their business interests. Class schedules and course descriptions for possible entrepreneurship electives can be found on the Simon Business School’s website.

TECHNICAL COURSES
A complete list of technical courses in the nine offered concentrations can be found online at www.rochester.edu/team/program/academics/.
Administrative Officers

Jamal J. Rossi, DMA
Joan and Martin Messinger Dean
Donna Brink Fox, PhD
Senior Associate Dean of Academic and Student Affairs
Marie Rolf, PhD
Senior Associate Dean of Graduate Studies

Committee on Graduate Studies

Dean Rolf (Chair), Professors Barr, Bucura, Chow, Esse, Freitas, Higgs, Lin, Liptak, Monahan, Morris, Rettzal, Silvey, Temperley, Terefenko, Van Demark, Watters, Weinert, D. Ying

Full-Time Faculty

Federico Agostini (National Conservatory, Venice, Italy)
Professor of Violin

Natalya Antonova (Leningrad Conservatory)
Professor of Piano

Christopher Azzara, PhD (Rochester)
Professor of Music Education

Jonathan Baldo, PhD (SUNY, Buffalo)
Professor of English

Jean Barr, DMA (Southern California)
Professor of Accompanying and Chamber Music

Bonita Boyd, BM (Rochester)
Professor of Flute

Kathleen Bride, MS (Juilliard)
Professor of Harp

Matthew Brown, PhD (Cornell)
Professor of Music Theory

Michael Burritt, MM (Rochester)
Professor of Percussion

Jeffrey Campbell, DMA (Rochester)
Professor of Jazz Studies and Contemporary Media

Tony Caramia, MM (SUNY, Fredonia)
Professor of Piano

Katherine Ciesinski, MM (Temple)
Professor of Voice

Kathryn Cowdrick, MS (Columbia)
Professor of Voice

Steven Daigle, MM (Florida State)
Professor of Opera

Steven Doane, MM (SUNY, Stony Brook)
Professor of Violoncello

William Dobbins, MA (Kent State)
Professor of Jazz Studies and Contemporary Media

Jonathan Dunby, PhD (Leeds, England)
Professor of Music Theory

Donna Brink Fox, PhD (Ohio State)
Eisenhart Professor of Music Education

Nicholas Goluses, DMA (Manhattan)
Professor of Guitar

Tony Griffey, MM (Rochester)
Professor of Voice

David Headlam, PhD (Michigan)
Professor of Music Theory

Benton Hess, BM (New England Conservatory)
Distinguished Professor of Voice

R. David Higgs, MM (Manhattan)
Professor of Organ

Douglas Humpherys, DMA (Rochester)
Professor of Piano

D. Clay Jenkins, MM (Southern California)
Professor of Jazz Studies and Contemporary Media

Renée Jolles, MM (Juilliard)
Professor of Violin

Richard Killmer, DMA (Yale)
Professor of Oboe

Henry Klumpenhower, PhD (Harvard)
Professor of Music Theory
Mikhail Kopelman (Moscow Conservatory)  
Professor of Violin

Oleh Krysa (Moscow Conservatory)  
Professor of Violin

W. Peter Kurau, MA (Connecticut)  
Professor of Horn

Nelita True Laires, DMA (Peabody)  
Professor of Piano

Vincent Lenti, MA (Rochester)  
Professor of Piano

David Liptak, DMA (Rochester)  
Professor of Composition

Elizabeth West Marvin, PhD (Rochester)  
Professor of Music Theory

Russell Miller, DMA (Michigan)  
Professor of Vocal Coaching and Repertoire

Robert Morris, DMA (Michigan)  
Professor of Composition

Paul O’Dette  
Professor of Lute and of Conducting and Ensembles

Marie Rolf, PhD (Rochester)  
Professor of Music Theory

Jamal Rossi, DMA (Rochester)  
Professor of Woodwinds

George Sakakeeny, BM (Rochester)  
Professor of Bassoon

Carlos Sanchez-Gutierrez, PhD (Princeton)  
Professor of Composition

Mark Scatterday, DMA (Rochester)  
Professor of Conducting and Ensembles

Oliver Schneller, DMA (Columbia)  
Professor of Composition

Barry Snyder, MM (Rochester)  
Professor of Piano

Reinhold Steingräver, PhD (SUNY, Buffalo)  
Professor of German

Robert Swensen, MM (Southern California)  
Professor of Voice

George Taylor  
Professor of Viola

David Temperley, PhD (Columbia)  
Professor of Music Theory

James Thompson, BM (New England)  
Professor of Trumpet

James Van Demark, BFA (SUNY, Buffalo)  
Professor of Double Bass

Neil Varon, MM (Juilliard)  
Professor of Conducting and Ensembles

Carol Webber, BM (Oberlin)  
Professor of Voice

William Weinert, DMA (Wisconsin)  
Professor of Choral Conducting

Ricardo Zohn-Muldoon, PhD (Pennsylvania)  
Professor of Composition

ASSOCIATE PROFESSOR

Michael Anderson, PhD (Chicago)  
Associate Professor of Musicology

Edoardo Bellotti, MM (Conservatory of Verona, Italy)  
Associate Professor of Organ, Harpsichord, and Improvisation

Alan Chow, MM (Juilliard)  
Associate Professor of Piano

Melina Esse, PhD (California, Berkeley)  
Associate Professor of Musicology

Roger Freitas, PhD (Yale)  
Associate Professor of Musicology

Kenneth Grant, BM (Rochester)  
Associate Professor of Clarinet

Don Harry, BM (Indiana)  
Associate Professor of Tuba

Bin Huang, DMA (Indiana)  
Associate Professor of Violin

Lisa Jakelsh, PhD (California, Berkeley)  
Associate Professor of Musicology

Mark Kellogg, BM (Rochester)  
Associate Professor of Euphonium, Trombone, and Brass Chamber Music

Chien-Kwan Lin, DMA (Rochester)  
Associate Professor of Saxophone

Bradley Lubman, MM (SUNY, Stony Brook)  
Associate Professor of Conducting and Ensembles

Glenn Mackin, PhD (Washington, Seattle)  
Associate Professor of Political Science

William Marvin, PhD (Rochester)  
Associate Professor of Music Theory

Seth Monahan, PhD (Yale)  
Associate Professor of Music Theory

Jan Opalach, BM (Indiana)  
Associate Professor of Voice

Jean Pedersen, PhD (Chicago)  
Associate Professor of History

Jonathan Retzlaff, DMA (Arizona State)  
Associate Professor of Voice

Masumi Rostad, MM (Juilliard)  
Associate Professor of Viola

Timothy Scheie, PhD (Wisconsin)  
Associate Professor of French

Robin Scott, BM (New England Conservatory)  
Associate Professor of String Chamber Music and Violin

Philip Silvey, EdD (Illinois, Urbana-Champaign)  
Associate Professor of Music Education

Dariusz Terefenko, PhD (Rochester)  
Associate Professor of Jazz Studies and Contemporary Media

Gary Versace, MM (Rochester)  
Associate Professor of Jazz Studies and Contemporary Media

Holly Watkins, PhD (California, Berkeley)  
Associate Professor of Musicology

Mark Watters, BM (Southern California)  
Associate Professor of Contemporary Media and Film Composition

David Ying, DMA (Rochester)  
Associate Professor of String Chamber Music and Violoncello

Janet Ying, BM (Rochester)  
Associate Professor of String Chamber Music
Phillip Ying, MM (Rochester)
   Associate Professor of String Chamber Music and Viola
Larry Zalkind, MM (Southern California)
   Associate Professor of Trombone

Elena Bellina, PhD (New York University)
   Assistant Professor of Italian
Zachary Bernstein, PhD (CUNY Graduate Center)
   Assistant Professor of Music Theory
Elizabeth Bucura, PhD (Arizona State)
   Assistant Professor of Music Education
Chelsea Burns, PhD (Chicago)
   Assistant Professor of Music Theory
Mara Culp, PhD (Pennsylvania State)
   Assistant Professor of Music Education
John Fetter, PhD (Rochester)
   Assistant Professor of Music Education
Orit Hilewicz, PhD (Columbia)
   Assistant Professor of Music Theory
Alexander Kobrin (Moscow Conservatory)
   Assistant Professor of Piano
Darren Mueller, PhD (Duke)
   Assistant Professor of Musicology
Alden Snell, PhD (Rochester)
   Assistant Professor of Music Education

General Information

The Eastman School of Music offers graduate programs leading to the Master of Arts, Master of Music, Doctor of Musical Arts, and Doctor of Philosophy degrees. Detailed information concerning these degree programs is found in the Official Bulletin of the Eastman School of Music of the University of Rochester and the supplement to that bulletin. All programs are under the administrative supervision of the school’s graduate committees: the Graduate Research Committee and the Graduate Professional Committee.

The Degree Master of Arts

Candidates who matriculate for the Master of Arts degree may major in music composition, music education, musicology, ethnomusicology, music theory, music theory pedagogy, or music leadership. The major in composition requires a thesis in the form of a major composition, to be accompanied by an analysis paper on a subject to be approved by the composition faculty. The programs of study in music education, in musicology, and in ethnomusicology require a written thesis, special project, or a field project, and candidates are expected to show marked ability in research. The major in music theory pedagogy requires a teaching recital, and the major in music leadership requires a supervised summer internship.

The Degree Master of Music

Major fields in which the degree Master of Music may be taken are performance and literature (vocal or instrumental), music composition, music education, early music, jazz studies and contemporary media (performance or writing), contemporary media/film composition, conducting (choral, instrumental, or wind), opera (stage directing), and piano accompanying and chamber music. Supplementing the prescribed coursework, the majors in performance and literature, early music, jazz studies and contemporary media, conducting, and opera (performance) require a public solo recital, and the major in piano accompanying and chamber music requires two such recitals. The major in composition requires a recital, a comprehensive review, and a thesis in the form of an orchestral work or a large chamber work. The major in contemporary media/film composition requires a recital and a media project. Candidates majoring in music education do not write a thesis but must pass a comprehensive written examination upon completion of their work. The major in opera (stage directing) requires a final directing project. The majors in accompanying and chamber music, conducting, early music, opera, and performance and literature also require an oral exam.

The Degree Doctor of Philosophy

Programs leading to the degree Doctor of Philosophy in music offer concentration in composition, music education, musicology, or theory. Candidates may include in their programs up to 6 credit hours in applied music, especially when such credit forms a part of a prior master’s degree. Candidates majoring in composition present an extended work for either orchestra, chorus, or large chamber ensemble, accompanied by a research paper dealing with some historical, theoretical, or analytical aspect of music. Candidates majoring in music education, musicology, or theory present a written dissertation which is the result of original research and which is expected to constitute a distinct contribution to knowledge.

The Degree Doctor of Musical Arts

The degree Doctor of Musical Arts (DMA) is designed to represent high attainment in the practice of music, with emphasis on the arts of performance and teaching. The candidate may major in performance and literature, composition, conducting, early music, jazz studies and contemporary media, music education, or piano accompanying and chamber music. In addition to the prescribed series of courses, requirements include the preparation of an acceptable dissertation, doctoral essay, or several research papers in addition to 2–3 recitals and a lecture-recital. A candidate for this degree must be first of all a capable practitioner of his or her art. Only those who meet rigorous standards in the field of practical music will be accepted for candidacy.
Graduate Awards

Each year the Eastman School of Music makes provisions to give Graduate Awards to a number of graduate students. These merit-based awards, which are made upon the recommendation of respective departments, may include graduate fellowships, or teaching, research, or departmental awards, depending on the type of service required. Graduate awards range in monetary value from partial tuition to full tuition plus stipend. To be recommended for a graduate award, an applicant must be accepted for graduate study and have special aptitude for teaching, research, performance, or composition. Awards are made for one year and are typically renewed after an annual review, at the Eastman School’s discretion.

Courses of Graduate Instruction

In addition to the 400- and 500-level coursework listed below, the Eastman School of Music offers a wide variety of courses at the 200 level that are open to both advanced undergraduate and graduate students. Graduate students enroll in 200-level courses for elective degree credit or credit toward a minor field. For a full listing of ESM courses, please visit www.esm.rochester.edu/registrar/courses/.

APPLIED MUSIC INSTRUCTION

Applied music instruction on a given instrument is available to graduate students in the following four categories:

### 430. Secondary Lessons

#### 430A (1, 11-1.5) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring Summer)

#### 430A. PRL Lessons Half-Hour

#### 430A (1, 11-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring Summer)

### 460A. Primary Lessons

#### 460A (1, 11-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring Summer)

### ACCOMPANYING (ACM)

#### 430. Sec Accompanying

#### 430 (1, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

#### 430A. Prl 1/2 Hr Accompanying

#### 430A (1, II-2) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

### 460. Primary Accompanying

#### 460 (1, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

### 460A. Primary Accompanying

#### 460A (1, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring Summer)

### ACCOMPANYING CLASS (ACY)

#### 405. Opera Coaching

ACY 405 (1-1) Opera Coaching: Study of the practical skills needed to coach opera singers and to prepare the pianist to work in a professional operatic environment. Arias and scenes from standard repertoire ranging from Mozart to present day will be selected. Special attention given to unique challenges of the lyric theater: stylistic interpretation of accompanied and secco recitative, the basics of vocal ornamentation as it applies to the stage, the creative realizing of piano transcriptions of orchestral accompaniments, playing conducted rehearsals, etc. Prerequisite: permission of the instructor. Strong interest in languages recommended. May be repeated for credit. (Fall)
415. English Lyric Diction
ACY 415 (I, II-1) English Lyric Diction Study of the basic rules of English lyric diction. Preparation and performance of English texts in musical settings. Intended for graduate piano accompanying majors; others by permission of instructor. (Fall Spring)

416. French Lyric Diction
ACY 416 (I, II-1) French Lyric Diction Study of the elements of French Diction through a progressive and holistic reading method. Application of that knowledge through oral exercises (in-class & assignments), written IPA assignments, performances (including tongue twisters, poetry reading, and art songs). Intended for graduate piano accompanying majors, graduate voice majors, and choral conducting majors; others by permission of instructor. (Fall Spring)

417. German Lyric Diction
ACY 417 (I, II-1) German Lyric Diction Comprehensive study of the rules for German lyric diction. Intended for graduate piano accompanying majors; others by permission of instructor. (Fall Spring)

418. Italian Lyric Diction
ACY 418 (I, II-1) Italian Lyric Diction Study of the basic rules of Italian lyric diction. Preparation and performance of Italian texts in musical settings. Intended for graduate piano accompanying majors; others by permission of instructor. (Fall Spring)

590. Independent Study

596. DMA Dissertation Project
6ACY 596 (I, II, S-credit to be arranged) DMA Dissertation Project (Fall Spring Summer)

ARTS LEADERSHIP CURRICULUM (6ALC)

411. Entrepreneurship in Music
6ALC 411 (I, II-1) Entrepreneurship in Music: Topics vary by semester and may be half-semester (early or late semester) or full semester courses. All graduate students can take ALP courses for free by registering at the ALC 400 level. Graduate students in certain instances may also wish or be required to register for other than the ALC 400 level and pay regular tuition charges. For additional information on this policy and further details on whether or not a course may be used to fulfill certificate, diploma, or degree requirements, please see the ALP website at http://www.esm.rochester.edu/iml/alp/gradpolicy.php (Fall Spring)

412. Entrepreneurship in Music
6ALC 412 (I, II-2) Entrepreneurship in Music: Topics vary by semester and may be half-semester (early or late semester) or full semester courses. All graduate students can take ALP courses for free by registering at the ALC 400 level. Graduate students in certain instances may also wish or be required to register for other than the ALC 400 level and pay regular tuition charges. For additional information on this policy and further details on whether or not a course may be used to fulfill certificate, diploma, or degree requirements, please see the ALP website at http://www.esm.rochester.edu/iml/alp/gradpolicy.php (Fall Spring)
degree requirements, please see the ALP website at http://www.esm.rochester.edu/iml/alp/gradpolicy.php (Fall Spring)

441. Contemporary Orchestral Issues
6ALC 441 (I, II-1) Contemporary Orchestral Issues: Topics vary by semester and may be half-semester (early or late semester) or full semester courses. All graduate students can take ALP courses for free by registering at the ALC 400 level. Graduate students in certain instances may also wish or be required to register for other than the ALC 400 level and pay regular tuition charges. For additional information on this policy and further details on whether or not a course may be used to fulfill certificate, diploma, or degree requirements, please see the ALP website at http://www.esm.rochester.edu/iml/alp/gradpolicy.php (Fall Spring)

451. The Healthy Musician
6ALC 451 (I.II-1) The Healthy Musician: Topics vary by semester and may be half-semester (early or late semester) or full semester courses. All graduate students can take ALP courses for free by registering at the ALC 400 level. Graduate students in certain instances may also wish or be required to register for other than the ALC 400 level and pay regular tuition charges. For additional information on this policy and further details on whether or not a course may be used to fulfill certificate, diploma, or degree requirements, please see the ALP website at http://www.esm.rochester.edu/iml/alp/gradpolicy.php (Fall Spring)

452. The Healthy Musician
6ALC 452 (I.II-2) The Healthy Musician: Topics vary by semester and may be half-semester (early or late semester) or full semester courses. All graduate students can take ALP courses for free by registering at the ALC 400 level. Graduate students in certain instances may also wish or be required to register for other than the ALC 400 level and pay regular tuition charges. For additional information on this policy and further details on whether or not a course may be used to fulfill certificate, diploma, or degree requirements, please see the ALP website at http://www.esm.rochester.edu/iml/alp/gradpolicy.php (Fall Spring)

480. Arts Leadership Internship
Arts Leadership Internship: Required for ALP Certificate Students / Scheduling flexible Open to Arts Leadership Program (ALP) certificate candidates only, the Catherine Filene Shouse Arts Leadership Program internship places ALP certificate candidates in internships designed to expose them to extra-musical tools and information that can only be learned in practical, “real world” settings. Benefits to the student include the cultivation of self-management skills and an awareness of the current climate for the arts in America. In addition to helping prepare our students to function in the ‘real world’, the internship program also contributes to the Eastman School’s focus on the community by supplying local, national and international arts organizations with high quality interns. Limited to 2 credits maximum towards certificate requirement. (Fall Spring)

BASSOON (BSN)

430. Sec Bassoon
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Bassoon
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Bassoon
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

CHAMBER MUSIC (CHB)

401. Instrumental Sonata & Duo Repertoire
6CHB 401 (I-2) Instrumental Sonata and Duo Repertoire: Intensive study of special topics from the instrumental & piano duo repertoire, selected at the beginning of the semester by the class. Open to graduate pianists, strings, & winds. Prerequisite: permission of instructor. May be repeated for credit. (Fall)

403. Piano Chamber Music Repertoire
6CHB 403 (I-2) Piano Chamber Music Repertoire: Intensive study of chamber music repertoire in a performance class setting. The course is team-taught by 2 members of the performance faculty. Up to 8 pre-formed groups are accepted. Each of them must include a pianist, and must submit their repertoire at the time of registration. Available to pianists, strings, winds & voice. Prerequisite: permission of instructor. May be repeated for credit. (Fall)

480. Graduate Seminar
6CHB 480 (0 Credits) Graduate Chamber Music: Coaching & performance of chamber music for strings, piano, winds, & brass. Includes Music for All performances(in the Spring semester) as well as in-house public performances. (Fall Spring)
481. Chamber Music  
6CHB 481 (I-1 cr. each, 2-semester course) Coaching & performance of chamber music for strings, piano, organ, winds, & brass. Includes a required in-house public performance. May be repeated for credit. (Fall)

482. Chamber Music  
6CHB 482 (II-1 cr. each, 2-semester course) Coaching & performance of chamber music for strings, piano, organ, winds, & brass. Includes Music for All performances as well as in-house public performances. May be repeated for credit. (Spring)

490. Independent Study

590. Independent Study

CLARINET (CL)

430. Sec Clarinet  
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Clarinet  
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Clarinet  
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

COMPOSITION (CMP)

401. Advanced Composition I  
Prerequisite: CMP 204.  
6CMP 401 (I, S-3) Advanced Composition I: Intensive work in free composition for chamber groups and orchestra. (Fall Summer)

402. Advanced Composition II  
Prerequisite: CMP 401.  
6CMP 402 (II, S-3) Advanced Composition II: Continuation. May terminate with a master’s thesis. Composition 401 and 402 may be repeated in the second year of the master’s degree program. (Spring Summer)

6CMP 412 (I-3) Compositional Practice circa 1925 to 1955: Offered every other year starting with the fall term of 2006. A writing and analysis course dealing with compositional trends in Europe and America from about 1925 to 1955 as demonstrated in the works of significant twentieth-century composers such as Bartok, Berg, Babbitt, Messiaen, Schoenberg, Stravinsky, Varese, Webern, and others. Class participation, three compositional projects, and a final exam are required. Intended for graduate students (undergraduates should register for CMP 212); others by permission of the instructor. May be taken independently from CMP 413. Required for all Composition MM and MA students. (Fall)

6CMP 413 (II-3) Compositional Practices circa 1955 to 1980: Offered every other year starting with the spring term of 2007. A writing and analysis course dealing with compositional trends in Europe and America from about 1955 to 1980 as demonstrated in the works of significant twentieth-century composers such as Adams, Boulez, Cage, Carter, Feldman, Ligeti, Penderecki, Reich, Stockhausen, Xenakis, and others. Class participation, two compositional projects, one aural report, and a final exam are required. Intended for graduate students (undergraduates should register for CMP 213); others by permission of the instructor. May be taken independently from CMP 412. Required for all Composition MM and MA students. (Fall)

421. Advanced Computer Music I  
Prerequisite: CMP 225-6 or equivalent.  
6CMP 421 (I, S-3) Advanced Computer Music Techniques: An intensive survey of advanced software-based techniques of digital recording, editing, synthesis, analysis and resynthesis, signal processing, mixing, spatial localization, ambience and movement, and current developments in the field. Class lecture/demonstrations are supplemented by weekly labs and culminate in student compositional projects. (Fall Summer)

422. Advanced Computer Music II  
Prerequisite: CMP 225-6 or equivalent.  
6CMP 422 (II, S-3) Advanced Computer Music Techniques: An intensive survey of advanced software-based techniques of digital recording, editing, synthesis, analysis and resynthesis, signal processing, mixing, spatial localization, ambience and movement, and current developments in the field. Class lecture/demonstrations are supplemented by weekly labs and culminate in student compositional projects. (Spring Summer)

430. Intro Classical Indian Music

435. Melharmony Workshop
440. Computer Engraving/Calligraphy
6CMP 440 (I-2) Computer Engraving and Other Forms of Calligraphy: This graduate course is open to all students. It will teach the standard notation guidelines (score layout, cueing of parts, dynamic and articulation placements, stem length, placement of accidentals, placement and font size for all words on the score, etc.) such that students can prepare materials ready for publication. While this course will introduce students to the various popular notation programs, it will provide in-depth instruction about one engraving program, and it will include several calligraphy projects. Undergraduate students should enroll in 6CMP 240. (Fall)

490. Independent Study

491. Composition Symposium
6CMP 491 (I-1) Composition Symposium (Graduate): Composition Symposium is a forum for presentations by guest composers and other speakers; there are also presentations and discussions by the students enrolled in the class. In preparation for each class meeting, students will be expected to familiarize themselves with the available work of our guest composers, to attend student composition performances that are the basis for Symposium discussions, and to prepare adequately for any special topics discussion that may be part of the schedule. (Fall)

492. Composition Symposium
6CMP 492 (II-1) Composition Symposium (Graduate): Composition Symposium is a forum for presentations by guest composers and other speakers; there are also presentations and discussions by the students enrolled in the class. In preparation for each class meeting, students will be expected to familiarize themselves with the available work of our guest composers, to attend student composition performances that are the basis for Symposium discussions, and to prepare adequately for any special topics discussion that may be part of the schedule. (Spring)

493. Composition Symposium
6CMP 493 (I-1) Composition Symposium (Graduate): Composition Symposium is a forum for presentations by guest composers and other speakers; there are also presentations and discussions by the students enrolled in the class. In preparation for each class meeting, students will be expected to familiarize themselves with the available work of our guest composers, to attend student composition performances that are the basis for Symposium discussions, and to prepare adequately for any special topics discussion that may be part of the schedule. (Fall)

494. Composition Symposium
6CMP 494 (II-1) Composition Symposium (Graduate): Composition Symposium is a forum for presentations by guest composers and other speakers; there are also presentations and discussions by the students enrolled in the class. In preparation for each class meeting, students will be expected to familiarize themselves with the available work of our guest composers, to attend student composition performances that are the basis for Symposium discussions, and to prepare adequately for any special topics discussion that may be part of the schedule. (Spring)

495. MA Thesis
6CMP 495 (I, II, S-credit to be arranged) M.A. Thesis: For the Master of Arts degree. (Fall Spring Summer)

496. MM Thesis
6CMP 496 (I, II, S-credit to be arranged) M.M. Thesis: For the Master of Music degree. (Fall Spring Summer)

501. Advanced Composition III
Prerequisite: CMP 402.
6CMP 501 (I, S-3) Advanced Composition: Free composition, with emphasis on works for orchestra. Limited to candidates for the doctorate in composition. These courses may be repeated for additional credit. (Fall Summer)

502. Advanced Composition IV
Prerequisite: CMP 402.
6CMP 502 (II, S-3) Advanced Composition: Free composition, with emphasis on works for orchestra. Limited to candidates for the doctorate in composition. These courses may be repeated for additional credit. (Spring Summer)

590. Independent Study

591. Composition Research Seminar
6CMP 591 (I-3) Composition Research Seminar: Seminars on selected topics. Research and class discussion will focus on technical, structural, analytical and aesthetic issues salient or unique to the selected repertory under examination - the music of our own time. Permission of instructor required. (Fall)

592. Composition Seminar
6CMP 592 (II-3) Composition Research Seminar: Seminars on selected topics. Research and class discussion will focus on technical, structural, analytical and aesthetic issues salient or unique to the selected repertory under examination - the music of our own time. Permission of instructor required. (Fall)

595. PhD Dissertation Project
6CMP 595 (I, II, S-credit to be arranged) PhD Dissertation Project (Fall Spring Summer)

596. DMA Dissertation Project
6CMP 596 (I, II, S-credit to be arranged) DMA Dissertation Project (Fall Spring Summer)
CONDUCTING (CND)

411. Grad Basic Conducting I
6CND 411 (I-2) Graduate Basic Conducting: Also requires registration for CND 411 Graduate Basic Conducting Lab. (Fall)

412. Basic Conducting Tech I
6CND 412 (I-2) Graduate Basic Conducting: Also requires registration for CND 412 Graduate Basic Conducting Lab. (Spring)

413. Intermed Conducting I: Instrumental
6CND 413 (I-2) Intermediate Conducting I (Instrumental): Further refinement of basic skills. Introduction to more advanced techniques of subdividing and compound meters. Repertoire studied varies from classical through romantic repertoire. This is a one year course & must be taken in sequence: CND 413 Intermediate Conducting I / CND 414 Intermediate Conducting II. Prerequisite is Graduate Basic Conducting or equivalent. Permission of instructor required. (Fall)

414. Intermed Conducting II: Instrumental
6CND 414 (II-2) Intermediate Conducting II (Instrumental): More advanced techniques, emphasis on compound meters (study of Stravinsky’s L’Histoire du Soldat), and accuracy of technique and musicality. This is a one year course & must be taken in sequence: CND 413 Intermediate Conducting I / CND 414 Intermediate Conducting II. Prerequisite is Graduate Basic Conducting or equivalent. Permission of instructor required. (Spring)

415. Advanced Conducting I: Instrumental
6CND 415 (I-2) Advanced Conducting I (Instrumental): Advanced Conducting is only available for conducting majors. Each semester, there are 4 sessions with Conductors Orchestra (CO). Each student will receive approximately 15 minutes of podium time per session. Preparation for these sessions will be by private lessons scheduled through each semester with Professor Lubman. PLEASE NOTE: Permission of instructor required. This course is not available as an elective. (Fall)

416. Advanced Conducting II: Instrumental
6CND 416 (II-2) Advanced Conducting II (Instrumental): Advanced Conducting is only available for conducting majors. Each semester, there are 4 sessions with Conductors Orchestra (CO). Each student will receive approximately 15 minutes of podium time per session. Preparation for these sessions will be by private lessons scheduled through each semester with Professor Lubman. PLEASE NOTE: Permission of instructor required. This course is not available as an elective. (Spring)

423. Advanced Conducting I: Choral
Prerequisites: CND 223, 224 (or equivalent) and permission of the instructor.
6CND 423 (I-2) A course focusing on repertoire analysis, gestural clarity and expression, and rehearsal technique in a wide variety of repertoire. (Fall)

424. Advanced Conducting II: Choral
6CND 424 (II-2) A continuation of Choral Conducting I, focusing on repertoire analysis, gestural clarity and expression, and rehearsal technique in a wide variety of repertoire. (Spring)

431. Grad Choral Literature I
6CND 431 (I-2) A survey of choral repertoire and performance practice from the middle ages through 1750. Offered in fall semesters, alternating years between CND 431 and CND 432. (Fall)

432. Grad Choral Literature II
6CND 432 (I-2) Grad Choral Literature: A comprehensive survey of choral materials suitable for church, secondary education, and college programs. CND 431 surveys repertoire and performance practice issues from the middle ages through 1750. CND 432 surveys repertoire and performance practice issues from 1750 to the present. Offered in fall semesters, alternating years between CND 431 and CND 432. (Fall)

441. Colloquy in Conducting
6CND 441 (I-0.5) Colloquy in Conducting: Study with various members of Conducting and Ensembles Department faculty. This course provides an opportunity to work with conductors outside student’s own area of expertise. (Fall)

442. Colloquy in Conducting
6CND 442 (II-0.5) Colloquy in Conducting: Study with various members of Conducting and Ensembles Department faculty. This course provides an opportunity to work with conductors outside student’s own area of expertise. (Spring)

443. Colloquy in Conducting
6CND 443 (I-0.5) Colloquy in Conducting: Study with various members of Conducting and Ensembles Department faculty. This course provides an opportunity to work with conductors outside student’s own area of expertise. (Fall)

444. Colloquy in Conducting
6CND 444 (II-0.5) Colloquy in Conducting: Study with various members of Conducting and Ensembles Department faculty. This course provides an opportunity to work with conductors outside student’s own area of expertise. (Spring)

461. Rehearsal Techniques I
6CND 461 (I-2) Rehearsal Techniques I and II: Concentration on freedom of movement and manual dexterity along with development of score study habits. Class members will prepare musical works from all periods of orchestral music for in-class discussion, trial and review. Class study culminates in the leadership of the Conducting Orchestra. May be repeated for credit. (rev. 8/1/05) (Fall)
462. Rehearsal Techniques II
6CND 262 (II - 2) Rehearsal Techniques I and II: Concentration on freedom of movement and manual dexterity along with development of score study habits. Class members will prepare musical works from all periods of orchestral music for in-class discussion, trial and review. Class study culminates in the leadership of the Conducting Orchestra. May be repeated for credit. (rev. 8/1/05) (Spring)

481. Orchestral Conducting
Prerequisite: CND 216 or the equivalent.
6CND 481 (I-3) Orchestral Conducting: Focus on score study, gesture technique, and practical rehearsal procedure. Class sections will focus on orchestral repertoire, and preparing the student for regular sessions conducting the ESM Conducting Orchestra. (Fall)

482. Orchestral Conducting
Prerequisite: CND 216 or the equivalent.
6CND 482 (II-3) Orchestral Conducting: Focus on score study, gesture technique, and practical rehearsal procedure. Class sections will focus on orchestral repertoire, and preparing the student for regular sessions conducting the ESM Conducting Orchestra. (Spring)

483. Orchestral Conducting
6CND 483 (I-3) Orchestral Conducting Focus on score study, gesture technique, and practical rehearsal procedure. Class sections will focus on orchestral repertoire, and preparing the student for regular sessions conducting the ESM Conducting Orchestra. (Fall)

484. Orchestral Conducting
Prerequisite: CND 216 or the equivalent.
6CND 484 (II-3) Orchestral Conducting: Focus on score study, gesture technique, and practical rehearsal procedure. Class sections will focus on orchestral repertoire, and preparing the student for regular sessions conducting the ESM Conducting Orchestra. (Spring)

541. DMA Conducting I
6CND 541 (I, II, S-4) DMA Conducting I: Private study with Conductor-Professor of Ensemble Specialty. Includes attendance at large ensemble rehearsals, section preparation, etc.; repertory study, ensemble rehearsal technique, interpretation, and advanced conducting problems. (Fall Spring Summer)

542. DMA Conducting II
6CND 542 (I, II, S-4) DMA Conducting II: Private study with Conductor-Professor of Ensemble Specialty. Includes attendance at large ensemble rehearsals, section preparation, etc.; repertory study, ensemble rehearsal technique, interpretation, and advanced conducting problems. (Fall Spring Summer)

543. DMA Conducting III
6CND 543 (I, II, S-4) DMA Conducting III: Private study with Conductor-Professor of Ensemble Specialty. Includes attendance at large ensemble rehearsals, section preparation, etc.; repertory study, ensemble rehearsal technique, interpretation, and advanced conducting problems. (Fall Spring Summer)

544. DMA Conducting IV
6CND 544 (I, II, S-4) DMA Conducting IV: Private study with Conductor-Professor of Ensemble Specialty. Includes attendance at large ensemble rehearsals, section preparation, etc.; repertory study, ensemble rehearsal technique, interpretation, and advanced conducting problems. (Fall Spring Summer)

590. Independent Study

596. DMA Dissertation Project
6CND 596 (I, II, S-credit to be arranged) DMA Dissertation Project (Fall Spring Summer)

DOUBLE BASS (DBL)

430. Sec Double Bass
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Double Bass
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)
460A. Primary Double Bass

460A (I, II-4) Graduate Applied Music Lessons (one-hour/week); Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

EASTMAN SCHOOL OF MUSIC (ESM)

401. Masters Degree Recital

402. Masters Jcm Degree Recital

405. MM Accompanying Recital With Vocalist

406. MM Accompanying Recital With Instrumentalist

410. Masters Improv Cert Recital

450. MM Listening Exam

455. MM Oral Exam

460. Composition Comprehen Review

470. Ped Theory Teaching Recital

475. MUE Cert Workshops

This course provides an overview of the edTPA and other testing requirements for certification, as well as the following required New York State Teacher Certification Workshops: 1. Literacy Workshop 2. Fire and Arson Awareness 3. Internet Safety 4. Save (Schools Against Violence in Education) Legislation 5. Harassment, Bullying, Cyberbullying & Discrimination: Prevention and Intervention (DASA) 6. Substance Abuse Awareness 7. Child Abuse Identification & Reporting (Fall)

501. First Doctoral Recital

502. Second Doctoral Recital

503. Doctoral Lecture Recital

504. DMA Piano Collab Recital

505. DMA Acm Recital With Vocalist

506. DMA Acm Recital With Instrumentalist

507. DMA Acm Third Recital

508. DMA Conducting Performance

510. Doctoral Improv Cert Recital

586V. Visiting Student in Residence

899. MUE Masters Cont Grad Enrol:

950. Doctoral Qualify Exam

985. Graduate Inactive Status

6ESM 985 Graduate Inactive Status: For graduate students who must temporarily delay progress in their program of study. Requires approval from the Associate Dean of Graduate Studies and the International Services Office (if applicable). (rev. 8/4/05) (Fall Spring)

995. Continuation of Graduate Enrollment: PT

6ESM 995 Continuation of Graduate Enrollment (Part Time): For graduate students who are completing non-credit-bearing degree requirements (e.g. writing dissertation, preparing recital). Students are not considered to be in residence and therefore comprehensive, activity, and health fees are not charged. Carries no credit; students are considered less than half-time and are not eligible for financial aid. Requires approval from the Associate Dean of Graduate Studies and the International Services Office (if applicable). (rev. 8/4/05) (Fall Spring)

999. Continuation of Graduate Enrollment: FT

6ESM 999 Continuation of Graduate Enrollment (Full Time): For graduate students who are completing non-credit-bearing degree requirements (e.g. writing dissertation, preparing recital). Students are considered to be in residence and therefore comprehensive, activity, and health fees are not charged. Carries no credit; students are considered full-time and are eligible for financial aid. Requires approval from the Associate Dean of Graduate Studies and the International Services Office (if applicable). (rev. 8/4/05) (Fall Spring)

999A. Cont Graduate Enrollment: FT

6ESM 999A Continuation of Graduate Enrollment (Full Time): For graduate students who are completing non-credit-bearing degree requirements (e.g. writing dissertation, preparing recital). Students are considered to be in residence (United States) and therefore are not subject to comprehensive, activity, and health fees. Carries no credit; students are considered full-time and are eligible for financial aid. Requires approval from the Associate Dean of Graduate Studies and the International Services Office (if applicable). (Fall Spring)

999B. Cont Graduate Enrollment: FT

6ESM 999A Continuation of Graduate Enrollment (Full Time): For graduate students who are completing non-credit-bearing degree requirements (e.g. writing dissertation, preparing recital). Students are considered to be in residence (Internationally) and therefore subject are not to comprehensive, activity, and health fees. Carries no credit; students are considered full-time and are eligible for financial aid. Requires approval from the Associate Dean of Graduate Studies and the International Services Office (if applicable). (Fall Spring)
ENSEMBLE (ENS)

400. Grad Ensemble: upper Rotation
6ENS 400 (I, II-1) Graduate Ensemble: Instrumental ensemble for graduate students. (Fall Spring)

400J. Graduate Jazz Ensemble
ENS 400J (I, II-1) Graduate Jazz Ensemble: Jazz Ensemble, New Jazz Ensemble, Jazz Lab Band. A multifaceted collection of jazz “big band” experiences that incorporate the study and presentation of jazz from historically significant repertory to new works composed by Eastman student writers. Ensembles accompany renowned jazz soloists, showcase the music of the finest jazz composers and arrangers, and present educational events for audiences across the country. Seating is determined by auditions in the fall. The 70-piece Studio Orchestra (combining Jazz Ensemble and Philharmonia/ESSO for three weeks annually) is periodically organized by assignment; no pre-enrollment is required. (Fall Spring)

401. Grad Brass Guild
6ENS 401 (I, II-0) Graduate Ensemble: Same as 6ENS 400, but for no credit and no charge. For MM PRL instrumental students who wish to participate in large ensembles, but do not need credit. Requires permission of the instructor. (rev 6/04/07) (Fall Spring)

401J. Graduate Jazz Ensemble
ENS 401J (I, II-0) Graduate Jazz Ensemble: Jazz Ensemble, New Jazz Ensemble, Jazz Lab Band. A multifaceted collection of jazz “big band” experiences that incorporate the study and presentation of jazz from historically significant repertory to new works composed by Eastman student writers. Ensembles accompany renowned jazz soloists, showcase the music of the finest jazz composers and arrangers, and present educational events for audiences across the country. Seating is determined by auditions in the fall. The 70-piece Studio Orchestra (combining Jazz Ensemble and Philharmonia/ESSO for three weeks annually) is periodically organized by assignment; no pre-enrollment is required. Same as 6ENS 400J, but for no credit and no charge. (Fall Spring)

407. Grad Collegium Musicum I

408. Grad Collegium Musicum II

415. Gamelan Ensemble

416. Introductory Mbira Ensemble

417. Advanced Mbira Ensemble

420. Graduate Chorale
6ENS 420 (I, II-2) Graduate Chorale (Fall Spring)

420A. Graduate Repertory Singers
6ENS 420A (I, II-1) Graduate Repertory Singers (Fall Spring)

420B. Graduate Eastman Rochester Chorus
6ENS 420B (I, II-1) Graduate Eastman Rochester Chorus (Fall Spring)

420C. Graduate Women’s Chorus
6ENS 420C (I, II-1) Graduate Women’s Chorus (Fall Spring)

421. Graduate Chorale
6ENS 421 (I, II-0) Graduate Chorale: Same as 6ENS 420, but for no credit and no charge. For MM PRL voice students who need 2 semesters of vocal ensemble, but not the credit. (Fall Spring)

421A. Graduate Repertory Singers
6ENS 421A (I, II-0) Graduate Repertory Singers: Same as 6ENS 420A, but for no credit and no charge. For MM PRL voice students who need 2 semesters of vocal ensemble, but not the credit. (Fall Spring)

421B. Graduate Eastman Rochester Chorus
6ENS 421B (I, II-0) Graduate Eastman Rochester Chorus: Same as 6ENS 420B, but for no credit and no charge. For MM PRL voice students who need 2 semesters of vocal ensemble, but not the credit. (Fall Spring)

421C. Graduate Women’s Chorus
6ENS 421C (I, II-0) Graduate Women’s Chorus: Same as 6ENS 420C, but for no credit and no charge. For MM PRL voice students who need 2 semesters of vocal ensemble, but not the credit. (Fall Spring)

442. Grad Trombone Choir

444. Graduate Brass Guild

445. Grad Horn Choir

446. Grad Eastman Saxophone Project
6ENS 446 (I, II-1) Graduate Eastman Saxophone Project: Preparation and performances of various styles of saxophone ensemble repertory. Prerequisite: Permission of Instructor (Fall Spring)

451. Graduate Orchestral Repertory
6ENS 451 (I-2) Orchestral Repertory: An in-depth survey of the standard repertory, particularly directed at preparing students for orchestral auditions and careers. May be repeated once for credit provided different repertory is covered. (Fall)
452. Graduate Orchestral Repertory
6ENS 452 (II-2) Orchestral Repertory: An in-depth survey of the standard repertory, particularly directed at preparing students for orchestral auditions and careers. May be repeated once for credit provided different repertory is covered. (Spring)

460. Grad Percussion Ensemble
6ENS 460 (I, II-1) Chamber Music (Percussion): Performance of music for percussion ensemble. (Fall Spring)

470. Conducting Ensemble
6ENS 470 (I, II-0) Conducting Ensemble: Conducting ensemble for "Graduate Award" contract holders only. (Fall Spring)

490. Independent Study

ETHNOMUSICOLOGY (ETH)

480. Approaches to Music Ethnography
6ETH 480 (II-3) Approaches to Music Ethnography: Ethnography offers a window into a variety of cultural worlds, and provides the foundation for theorizing in anthropology and in related disciplines like ethnomusicology. In this course, we examine ways in which anthropologists and ethnomusicologists conduct ethnographic research and write ethnography. We will look at a range of analytic and interpretive approaches to ethnography, learn fundamental techniques for conducting ethnographic research, and consider ethical aspects of such work, exploring contemporary debates about the practice and production of ethnography. Also cross-listed as ANR 280. (Fall)

490. Independent Study

495. MA Thesis
6ETH 495 (I, II, S-credit to be arranged) M.A. Thesis: Students will design and implement a semester-long fieldwork project carried out in the Rochester area, or another area of the student’s choice. The project will result in a substantial paper and oral presentation. Projects will be monitored by the department faculty. (Fall Spring Summer)

502. Introduction to Ethnomusicology
6ETH 502 (II-4) Introduction to Ethnomusicology: This course explores some of the world’s musical cultures and the social, political and religious systems that provide a context for music performances of all kinds. Traditional and classical music systems from Native America, Europe, Africa, Asia, and the Mediterranean will be examined with an emphasis on listening and analytic skills. Assignments include reading, listening, video, and ethnographic projects, and a mid-term and final exam. (Spring)

590. Independent Study

EUPHONIUM (EUP)

430. Sec Euphonium
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Euphonium
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Euphonium
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

FLUTE (FL)

430. Sec Flute
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring Summer)

430A. Prl 1/2 Hr Flute
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring Summer)

460. Primary Flute
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)
460A. Primary Flute
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

GERMAN (GER)

490. Independent Study

590. Independent Study

GUITAR (GTR)

430. Sec Guitar
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hour-Guitar
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Guitar
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

GUITAR CLASS (GTC)

401. Sem in Guitar Studies
6GTC 401 (I-2) Seminar in Guitar Studies: Examination and integration of guitar literature, fretboard harmony, guitar pedagogy, and research techniques. Students research the instruments, styles, notation systems, composers, and repertory of the guitar. Professional activities are also addressed. Required of all guitarists in the MM PRL program. (Fall)

402. Sem in Guitar Studies
6GTC 402 (II-2) Seminar in Guitar Studies: Examination and integration of guitar literature, fretboard harmony, guitar pedagogy, and research techniques. Students research the instruments, styles, notation systems, composers, and repertory of the guitar. Professional activities are also addressed. Required of all guitarists in the MM PRL program. (Spring)

HARP (HRP)

430. Sec Harp
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Harp
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

HARPSICHORD (HPC)

430. Sec Harpsichord
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Hrpschrd
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Harpsichord
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Harpsichord
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)
HORN (HRN)

430. Sec Horn
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. 1/2 Hr Horn
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Horn
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Horn
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

490. Natural Horn Studies: Kurau
An exploration of topics relating to the historical horn (natural horn), including performance technique and practice, development of the instrument, stylistic approach, and contemporary issues. Repertoire will be primarily Classical, although Baroque and Contemporary works may be examined. (Fall Spring)

HUMANITIES (HUM)

490. Independent Study

ITALIAN (IT)

590. Independent Study

JAZZ LESSONS (JAZ)

430. Sec Jazz
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. 1/2 Hr Jazz
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for JCM graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Jazz
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Jazz
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for JCM graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

JAZZ STUDY & CONTEMPORARY MEDIA (JCM)

407. Graduate Jazz Ensemble Direction
Prerequisite: JCM 406 or instructor’s permission.

JCM 407 (II-1) Graduate Jazz Ensemble Direction: The course helps to develop the essential skills for directing a large jazz ensemble. Students learn to select, analyze and prepare repertoire, how to develop transposition and relevant keyboard skills, how to plan and carry out an organized and productive rehearsal, and how to relate to a specific or general type of audience. (Spring)

431. Studio Orchestra Arranging
Prerequisite: JCM 225.

JCM 431 (I-2) Studio Orchestra Arranging: Essential techniques of arranging for studio orchestra are developed through the study of jazz-related classical orchestral works and works by jazz arrangers and composers from a wide range of jazz styles. Student works are read by the Eastman Studio Orchestra and selected works are performed on the orchestra’s annual concert. (Fall)

433. Film Scoring Techniques I

434. Film Scoring Techniques II
435. Arranging for the Recording Studio
JCM 435 (I-2) Arranging for the Recording Studio: This class is a hands-on approach to arranging for the recording studio. Rough (bed) tracks will be used for students to arrange and record their projects over. Arrangements will be done for woodwinds, brass and strings in different projects. Voicing techniques and instrumental combinations will be taught and discussed in class. Pre-requisites: JCM 223, JCM 224 (Fall)

441. Advanced History & Analysis of Jazz Styles
Prerequisite: JCM 241 or permission of instructor.
JCM 441 (II-3) Advanced History and Analysis of Jazz Styles: Investigation of performance and compositional innovations in jazz in the twentieth century. Analysis of scores, transcriptions, and recordings by major jazz stylists. (Spring)

451. Jazz Performance Workshop (Graduate)
JCM 451 (I-1) Jazz Performance Workshop (Graduate): This course combines a thorough study of improvisation, jazz theory, aural training, and small group performance practice in seven classroom environments built around small ensembles. Resulting chamber ensembles perform throughout the year in Jazz Forums, and other school and public venues. Participation in this course is limited to JCM majors. (Four semesters required for MM JCM degree, two semesters required for MM JCW degree.) (Fall)

452. Jazz Performance Workshop (Graduate)
JCM 452 (II-1) Jazz Performance Workshop (Graduate): This course combines a thorough study of improvisation, jazz theory, aural training, and small group performance practice in seven classroom environments built around small ensembles. Resulting chamber ensembles perform throughout the year in Jazz Forums, and other school and public venues. Participation in this course is limited to JCM majors. (Four semesters required for MM JCM degree, two semesters required for MM JCW degree.) (Spring)

454. Contemporary Style Compositi
JCM 454 (I, II-2) This seminar focuses on composing music in contemporary styles with particular emphasis on film and video game usage. Styles include Pop, Rock, Country and Electronic Dance Music (EDM). Through analysis and model composition, the student will write assignments in these various styles. (Fall) (Spring)

456. Jcm Media Project
JCM 456 (I, II-0) JCM MM Media Project: Preparation and finalizing a media related product which showcases the graduate student's area of focus. (Fall) (Spring)

475. Writing Proj: Contemp Media
JCM 475 (I-3) These private lessons will guide the student with composition for all facets of this degree, but will primarily focus on collaborative concert music. In essence, acoustic media, including: Music for Dance (with a choreographer), Music for Theater (with a librettist, playwright, or poet), Music for Still Images (with a photographer), Music for Video Images (with a video- rapher) more like a ballet than a film score, Music with a Lighting Component (with a light artist), Extended Concert Works. Over the course of this degree, the student will compose at least three collaborative works ranging from five to fifteen minutes in length. An ad-hoc ensemble will be formed to perform the student’s work at the end of each semester. (Fall)

476. Writing Proj: Contemp Media
JCM 476 (I-3) These private lessons will guide the student with composition for all facets of this degree, but will primarily focus on collaborative concert music. In essence, acoustic media, including: Music for Dance (with a choreographer), Music for Theater (with a librettist, playwright, or poet), Music for Still Images (with a photographer), Music for Video Images (with a video- rapher) more like a ballet than a film score, Music with a Lighting Component (with a light artist), Extended Concert Works. Over the course of this degree, the student will compose at least three collaborative works ranging from five to fifteen minutes in length. An ad-hoc ensemble will be formed to perform the student’s work at the end of each semester. (Fall)

481. Special Topics in Jazz Studies and Contemporary Media
JCM 481 (I-2) Special Topics in Jazz Studies and Contemporary Media: Specific topics and instructors to be announced in advance. May be repeated for credit. Permission of instructor required. (Fall)

482. Special Topics in Jazz Studies and Contemporary Media
JCM 482 (II-2) Special Topics in Jazz Studies and Contemporary Media: Specific topics and instructors to be announced in advance. May be repeated for credit. Permission of instructor required. (Spring)

483. Advanced Studies in Improvisation
JCM 483 (I-4) Advanced Studies in Improvisation: Jazz improvisation and theory instruction for the graduate DMA JCM major. Emphasis upon development of student works and recording production/live performance matters pertaining to graduate recitals. Permission of instructor required. (Fall)

484. Advanced Studies in Improvisation
JCM 484 (II-4) Advanced Studies in Improvisation: Jazz improvisation and theory instruction for the graduate DMA JCM major. Emphasis upon development of student works and recording production/live performance matters pertaining to graduate recitals. Permission of instructor required. (Spring)

485. MM Writing Projects: Jazz
JCM 485 (I-3) MM Writing Projects: Jazz composition and arranging instruction for the graduate MM JCW major. Emphasis upon development of student works and recording production/
live performance matters pertaining to the graduate recitals. Permission of instructor required. (Fall)

486. MM Writing Proj: Jazz
JCM 486 (II-3) MM Writing Projects: Jazz composition and arranging instruction for the graduate MM JCW major. Emphasis upon development of student works and recording production/live performance matters pertaining to the graduate recitals. Permission of instructor required. (Spring)

487. Adv Studies: Jazz Composition

488. Adv Studies: Jazz Composition

490. Independent Study

491. Jazz Forum (Graduate)
JCM 491 (I-0) Jazz Forum (Graduate): A weekly departmental gathering in which jazz faculty, visiting artists, and students from JPWs appear in performance. At other times there are discussions of departmental and current jazz topics, and exploration of new compositions, arrangements, and contemporary recorded works by professional composers and arrangers, as well a student and faculty works. Prerequisite: JCM major. Graduate students attend and perform in forums for no credit/no charge. (Fall)

492. Jazz Forum (Graduate)
JCM 492 (II-0) Jazz Forum (Graduate): A weekly departmental gathering in which jazz faculty, visiting artists, and students from JPWs appear in performance. At other times there are discussions of departmental and current jazz topics, and exploration of new compositions, arrangements, and contemporary recorded works by professional composers and arrangers, as well a student and faculty works. Prerequisite: JCM major. Graduate students attend and perform in forums for no credit/no charge. (Spring)

501. Large Jazz Ensemble
JCM 501 (I, II-0) Large Jazz Ensemble: Same as 6JCM 400, but for no credit and no charge. For DMA JCM students who participate in large ensembles, but do not need credit. Requires permission of the instructor. (rev 7/09/08) (Fall Spring)

523. Theory/Practice Harmony
JCM 523 (II-3) Harmonic Techniques: A study of harmonic techniques and musical repertoire of ten influential composers (Liszt, Debussy, Szymanowski, Scriabin, Schoenberg, Webern, Bartok, Berg, Messiaen, Shostakovich) and their relevance to jazz. Permission of Instructor Required. (Spring)

524. Theory of Improvisation
Prerequisite: JCM 523: Harmonic Techniques
JCM 524 (I-3) Theory of Improvisation: A study of improvisational concepts (800AD - present), theoretical treatises that include sections on pedagogy and techniques of improvisation (Thomas de Sancta Maria, Zarlino, Niedt, C.P.E Bach, C. Czerny, H. Schenker), and musical compositions that are improvisatory in nature (fantasias, unmeasured preludes, partimenti, solo cadenzas, suites, theme and variations). Permission of instructor required. (Fall)

535. Arranging for the Recording Studio
JCM 535 (I-2) Arranging for the Recording Studio: This class is a hands-on approach to arranging for the recording studio. Rough (bed) tracks will be used for students to arrange and record their projects over. Arrangements will be done for woodwinds, brass and strings in different projects. Voicing techniques and instrumental combinations will be taught and discussed in class. Prequisites: JCM 223, JCM 224 (Fall)

551. DMA Jazz Performance Workshop
JCM 551 (II-2) Jazz Performance Workshop (Graduate): This course combines a thorough study of improvisation, jazz theory, aural training, and small group performance practice in seven classroom environments built around small ensembles. Resulting chamber ensembles perform throughout the year in Jazz Forums, and other school and public venues. Participation in this course is limited to JCM majors. (Spring)

552. DMA Jazz Performance Workshop
JCM 552 (II-2) Jazz Performance Workshop (Graduate): This course combines a thorough study of improvisation, jazz theory, aural training, and small group performance practice in seven classroom environments built around small ensembles. Resulting chamber ensembles perform throughout the year in Jazz Forums, and other school and public venues. Participation in this course is limited to JCM majors. (Fall)

590. Independent Study

596. DMA Dissertation Project
JCM 596 (I, II, S-credit to be arranged) DMA Dissertation Project (Fall Spring)

KEYBOARD (KBD)

401. Sacred Music Skills I
6KBD 401 (I-2, alternate years) Sacred Music Skills I: Focuses on the choral responsibilities of the church musician and the history, function, and future of liturgical music practices in the Christian Church tradition. The course includes sessions on training the voice, phonetics, English and Latin diction, chanting, conducting, and choral rehearsal techniques. In addition to assigned special projects, students will participate through weekly rehearsing of the class as choir. “Lab” time for honing students skills will be available during the semester. (Fall)

402. Sacred Music Skills II
6KBD 402 (II-2, alternate years) Sacred Music Skills II: Focuses on choral repertoire and anthem/motet planning and rehearsing. Students will program anthems/motets for the church year
(A,B,C) based on the The Revised Common Lectionary. The course will explore innovative ways to enhance the liturgy with music within the context of the evolution of liturgical practices. Students will be guided in rehearsing the class in choral repertoire, listening to musical examples, studying scores, class discussion, and student presentations. “Lab” time for honing students’ skills will be available during the semester. (Spring)

403. Sacred Music Skills III
6KBD 403 (I-2, alternate years) Sacred Music Skills III: Focuses on essential keyboard skills for the church/synagogue musician, with emphasis on congregational song in various religious environments and traditions. Primary areas of instruction include hymn playing (introductions, reharmonizations, performance practices of various styles and traditions), anthem accompaniment, adapting piano/orchestral accompaniments to the organ, conducting from the organ console, and a survey of Christian hymnody. Each student will receive several individual coachings during the semester. Open to keyboard majors or by permission. (Fall)

404. Sacred Music Skills IV
6KBD 404 (II-2, alternate years) Sacred Music Repertoire: This class focuses on the training of young vocal and instrumental musicians through early musical training and the creation of opportunities for their involvement in the musical life of the church. Choral and handbell repertoire will be explored, and conducting techniques specific to younger participants will be learned. In addition to assigned special projects, each student will participate through occasional supervised conducting of children’s and handbell choirs at a local church. Also included are sessions on the administration of a large music program. Open to keyboard majors or by permission. (Fall)

405. Graduate Organ Improvisation
Prerequisites: TH 475, TH 476 or permission of instructor.
6KBD 405 (I-II-1) Organ Improvisation: The purpose of this course is to develop skills and techniques in musical improvisation, beginning with harmonization of hymns and chorales and progressing to work in building skills in a variety of genres and styles. Sections consist of semi-private lessons in small groups of 2-4 students. (Fall Spring)

407. Harpsichord Performance and Literature
6KBD 407 (I-II-2) Harpsichord Performance and Literature: The course gives a historical view of harpsichord music from its origin to the late 18th century and aims to give harpsichord students the information and resources to approach the repertoire correctly. Each lesson is focused on a particular historical period or musical form. Through the analysis of selected compositions, the essential elements of the style of the composer and/or the time are derived. Students deepen their understanding and knowledge of the topic through regular assignments. (Fall Spring)

411. Piano Literature I: 18th C
6KBD 411 (II-3) Piano Literature I (18th Century): A survey of piano repertoire from the baroque and classical periods. The course syllabus includes reading and listening assignments, analysis and performance projects, and midterm and final exams. Suitable as elective credit for graduate piano students. (Spring)

412. Piano Literature II: 19th C
6KBD 412 (I-3) Piano Literature I (19th Century): A survey of piano repertoire from the romantic period. The course syllabus includes reading and listening assignments, analysis and performance projects, and midterm and final exams. Suitable as elective credit for graduate piano students. (Spring)

413. Piano Literature III: 20th C
6KBD 413 (II-3) Piano Literature I (20th Century & Beyond): A survey of solo piano literature from the twentieth and twenty-first centuries. The course syllabus includes reading and listening assignments, analysis and performance projects, and midterm and final exams. Suitable as elective credit for graduate piano students. (Spring)

421. Organ Repertoire I
6KBD 421 (I-2) Organ Repertory I: A survey of solo organ repertoire, instrument-building traditions and performance practice studies from Antiquity through the seventeenth century. (Fall)

422. Organ Repertoire II
6KBD 422 (II-2) Organ Repertory II: A survey of solo organ repertoire, instrument-building traditions and performance practice studies from middle of the seventeenth century through the eighteenth century, with special focus on the North German and French Classic schools, and the organ music of Johann Sebastian Bach. (Spring)

423. Organ Repertoire III
6KBD 423 (I-2) Organ Repertory III: A survey of solo organ repertoire, instrument-building traditions and performance practice studies from nineteenth-century Germany and France. (Fall)

424. Organ Repertoire IV
6KBD 424 (II-2) Organ Repertory IV: A survey of solo organ repertoire, instrument-building traditions and performance practice studies from nineteenth-century England and North America, and twentieth-century Europe and North America through the present. (Spring)

442. Pa Rep & Its Interpreters
6KBD 442 (I-3) Piano Repertory and Its Interpreters: An intensive examination of a specific area of the piano repertoire; topics to vary from year to year (e.g., Chopin solo works, Beethoven sonatas and concertos, Bach Well-Tempered Clavier and other solo works, etc.) The class addresses its subject material from the dual perspectives of the literature itself and of the artists who
have been historically associated with the literature. May be repeated for credit. (Fall)

443. Keyboard Continuo Realization
6KBD 443 (I-1) Keyboard Continuo Realization: The first semester course focuses on helping the student become proficient in realizing the basic figures, following the development of continuo during 17th – 18th century, with a particular attention to the relationship between thorough bass and counterpoint. (Fall)

444. Keyboard Continuo Realization
6KBD 444 (II-1) Keyboard Continuo Realization: In the second semester the course works with the characteristics of particular French, German, and Italian styles, including the Rule of the Octave and the accompaniment of the recitative. Special emphasis on the various national styles. Prerequisite: TH 476 or fluency in reading figured bass. Simultaneous enrollment in CHB 277 strongly encouraged. (Spring)

450. Jazz Piano for Keyboard Majors (I: Harmonization)
6KBD 450 (I-2) Jazz Piano for Keyboard Majors (I: Harmonization): For advanced keyboard players with experience in jazz piano. Topics include complete analysis of jazz harmonies and their application to standards. Open to ESM majors only. (Fall)

451. Jazz Piano for Keyboard Majors (II: Improvisation)
6KBD 451 (II-2) Jazz Piano for Keyboard Majors (II: Improvisation): For advanced keyboard players with experience in jazz piano. Topics include complete analysis of jazz improvisation, including blues and standards. Open to ESM majors only. (Fall)

461. Organ History, Design & Mntn
6KBD 461 (I, II-2) Historical Development of the Organ: Its Design and Maintenance: This course will cover pipe organ functionality and design to include the major historic schools of organbuilding. It will also include practical training and maintenance techniques and “hands on” participation in a pipe organ restoration and installation project. This class meets weekly as a group for one hour, with one additional hour per week of lab to be scheduled based on the student’s availability. Required for undergraduate organ majors; open to others by permission of the instructor. (Fall Spring)

491. Organ Department Colloquium
6KBD 491 (I-0) Organ Department Colloquium: Each Monday evening, the entire organ department gathers for a session devoted to relevant professional topics and practical work in aspects of sacred music practice. Some sessions involve a guest master class or lecture, as well as faculty and student presentations. Also, over the course of one academic year, each student prepares a hymn to play on the organ, while the class and faculty function as the congregation. Likewise, each student prepares a choral anthem with organ accompaniment, and rehearses the class and faculty as if they were a choir, and then conducts and accompanies simultaneously a performance. Consequently, each student performs one hymn and one anthem per year for the helpful feedback of colleagues and teachers. Colloquium is held in Schmitt Hall, but sometimes at Memorial Art Gallery or a local church in order to use those instruments and spaces. (Fall)

492. Organ Department Colloquium
6KBD 492 (I-0) Organ Department Colloquium: Each Monday evening, the entire organ department gathers for a session devoted to relevant professional topics and practical work in aspects of sacred music practice. Some sessions involve a guest master class or lecture, as well as faculty and student presentations. Also, over the course of one academic year, each student prepares a hymn to play on the organ, while the class and faculty function as the congregation. Likewise, each student prepares a choral anthem with organ accompaniment, and rehearses the class and faculty as if they were a choir, and then conducts and accompanies simultaneously a performance. Consequently, each student performs one hymn and one anthem per year for the helpful feedback of colleagues and teachers. Colloquium is held in Schmitt Hall, but sometimes at Memorial Art Gallery or a local church in order to use those instruments and spaces. (Fall)

590. Independent Study

LUTE (LUT)

430. Sec Lute
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Lute
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Lute
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)
MUSIC HISTORY (MHS)

414. History of Jazz Styles

421. Music in the Middle Ages

6MHS 421 (II-3) Music in the Middle Ages: This course explores Western European music traditions from the ninth century to the early fifteenth century. The course not only emphasizes changes in musical style, structure and form, but also accounts for the social significance of composition and the reception of music in this broad period. By the end of the term, students will be able to articulate the changes in genres and musical styles over this span of history and use the major intellectual currents and social climates of the period to help explain the rise and function of these musics. (Spring)

422. Music in the Renaissance

6MHS 422 (I-3) Music in the Renaissance: Music of the early modern period from 1400 to 1600 is the focus of the course. Areas of emphasis include the development of vocal genres (motet, Mass, chanson, madrigal), as well as distinct types of instrumental music. Overviews of political, artistic and social developments will contextualize the activity of composers and musicians. Also addressed are issues such as the interactions of patrons and composers, Franco-Flemish and Italian musical styles, and music and rhetoric. Basic theoretical underpinnings such as mode, hexachord, and notational conventions are covered, along with strategies for locating distinctive aesthetic features of works composed in a variety of styles and genres. (Fall)

423. Music in the Baroque

6MHS 423 (II-3) Music in the Baroque: This course examines the music and culture of the so-called baroque period in music, from the birth of monody and opera to the deaths of Bach and Handel. In order of increasing importance, the course aims to explore: 1) the origins and development of important genres; 2) the general development of style; and 3) the social and political environments in which baroque music was written, performed, and consumed. The course will consider the works of the major composers of the period, as well as those that were originally unpopular but are now staples in the repertoire. It will take a prismatic approach to the study of music in its cultural, sociological, and historical contexts, and through formal and theoretical analysis. By following a work from composition to performance to reception, and through active listening, score study, and text reading, we will explore what makes a work of music “classic.” A literature review paper, a personal repertoire paper, and assigned readings and listening make up the workload. This class is open to all MM and DMA students with the understanding that there will be an increased workload for DMA students. For MM students, the course fulfills 1 elective credit as well as the listening exam requirement. (Fall Spring)

424. Music in the Classic Period

6MHS 424 (I-3) Music in the Classic Period: Although the works of Haydn, Mozart, and Beethoven serve as the primary “texts” of this course, close attention is paid to the history of styles and contexts of music-making from the so-called early classic period through the early 19th century. The relation of musical style to genre, performance venue, and audience is considered alongside changes in systems of patronage, dissemination of music as a commodity, private and public concert traditions, and performance practices documented in contemporary treatises. (Fall)

425. Music in the 19th Century

6MHS 425 (I-3) Music in the Nineteenth Century: This course will not only deal with the history of musical style in nineteenth-century Europe, it will also explore music’s cultural contexts and social meanings. Through a study of the major genres of the era (symphony, Lieder, opera, piano miniatures, etc.) we will explore how music embodied social, political, and gendered meanings in both public and private spheres. We will encounter new works (as well as ask new questions about familiar pieces) and will engage in close and careful analysis of sounds, scores, and the written word. Our primary goals are to gain a broad sense of nineteenth-century musical life and to learn how to communicate opinions and ideas about music thoughtfully, clearly, and persuasively. (Fall)

426. Music Since 1900

6MHS 426 (I, II-3) Music Since 1900: This course is designed to provide a solid grasp of twentieth-century European and American art music by offering both broad coverage of significant works and in-depth examination of the era’s diverse musical trends, social and political environments, and aesthetic and cultural controversies. Students are expected to contribute to class discussion, engage closely with musical scores, listen attentively to pieces, and write sensitively about compositional details as well as music’s multiple roles in contemporary culture. Major graded work includes a midterm, final, and a paper that combines analysis and interpretation. (Fall)

435. Concert Repertoire: Museum Or Living Art?

6MHS 435 (I-3) Concert Repertoire: Museum or Living Art?: This course will examine some major works that have stood the test of time and have entered the musical “canon,” as well as others that were originally unpopular but are now staples in the repertoire. It will take a prismatic approach to the study of music in its cultural, sociological, and historical contexts, and through formal and theoretical analysis. By following a work from composition to performance to reception, and through active listening, score study, and text reading, we will explore what makes a work of music “classic.” A literature review paper, a personal repertoire paper, and assigned readings and listening make up the workload. This class is open to all MM and DMA students with the understanding that there will be an increased workload for DMA students. For MM students, the course fulfills 1 elective credit as well as the listening exam requirement. (Fall Spring)

441. Baroque Performance Practice I

6MHS 441 (I-2) Baroque Performance Practice I: An introduction to the study of historical performance practice with an emphasis on Baroque music. Principles of rhetoric, affect, articulation, phrasing, expression, rhythmic alteration, dotting, tuning and temperament based on historical sources. Designed to combine with MHS 443 as a comprehensive study of Baroque performance practices. (Fall)
442. Baroque Performance Practice II
6MHS 442 (II-2) Baroque Performance Practice II: Dance music, tempo, tactus, ornamentation, improvisation, recitative, Baroque opera practice and a special session on performance practice issues in Bach, based on historical sources. Prerequisite: MHS 441 recommended. (Spring)

443. Performance Practice: Baroque
Prerequisite: MHS 441 recommended
6MHS 443 (II-2) Performance Practice: Baroque: Dance music, tempo, ornamentation, improvisation, Baroque opera practice and a special session on performance practice issues in Bach, based on historical sources. (Spring)

480. Bibliography
6MHS 480 (I, II-2) Bibliography: A study of sources and reference materials in music. (Fall Spring)

481. Special Topics in Music History
6MHS 481 (I-3) Special Topics: Intensive study of literature within limited topic areas. Emphasis upon analysis and comparative studies, with critical writing by the student. May be repeated for credit. Recent offerings include: Shakespeare & Music; The Symphonies of Beethoven; 19th c. Performance Practice, Symphony after Beethoven, Musical Borrowing, Debussy and Paris, History of Jazz (for non-jazz majors), Asian Classical Musics, Race and Gender in American Music. (Fall)

482. Special Topics in Music History
6MHS 482 (II-3) Special Topics: Intensive study of literature within limited topic areas. Emphasis upon analysis and comparative studies, with critical writing by the student. May be repeated for credit. Recent offerings include: Shakespeare & Music; The Symphonies of Beethoven; 19th c. Performance Practice, Symphony after Beethoven, Musical Borrowing, Debussy and Paris, History of Jazz (for non-jazz majors), Asian Classical Musics, Race and Gender in American Music. (Fall)

490. Independent Study

590. Research Seminars
6MHS 590 (I, II, S-3) Research Seminars: Seminars and independent studies on selected topics. May be repeated for credit. Recent offerings include: The Bach Organ; Handel’s Italian Vocal Music; The Mass from Chant to Stravinsky; Music and Ritual; Reading Mozart’s Operas; The Symphony, 1800-1900; Studies in the German Lied; 19th c. Performance Practice; Romantic Music and Critics; Song after Schubert; Operas of Richard Wagner; Asian Classical Musics; American Musics; Popular Music from the Margins; Music and Postmodernism; The Improvising Musician; Music, Gender, and the Body; National Styles & Exoticism; 20th-century Voice and Spectacle. (Fall Spring Summer)

MUSIC TEACHING & LEARNING (MUE)

402. Measurement & Evaluation
6MUE 402 (I, S-3) Measurement and Evaluation: This course reviews published aptitude and achievement tests and includes interpretation of test scores, administration of tests, and experience in developing tests. (Fall Summer)

403. Introduction to Research
6MUE 403 (II, S-3) Introduction to Research in Music Education: This course is designed for graduate students to develop an overview of the existing published research in music education. Content includes vocabulary and concepts related to quantitative and qualitative research designs in music education. Daily/weekly assignments to critique and analyze studies lead to a final review of literature paper and presentation. (Spring Summer)

404. The Psychological Foundations of Musical Behavior
6MUE 404 (II-2) The Psychological Foundations of Musical Behavior: Although psychological issues are touched on in both the MUE 401 (Introduction to Research) and MUE 501 (Seminar I: History and Philosophy) courses, this one-semester course is designed to expose graduate students to more depth of information, current research, and to guest experts who are equipped to provide detailed input on certain specialized areas of psychology related to musical behavior. (Spring)

411. Early Childhood Music Education
6MUE 411 (I-2) Early Childhood Music Education: Orientation toward teaching music to children aged infant to 8 years. Links home and community environments to the music learning environment, and examines young children’s motivation to learn music. Language development and musical development are compared. Observation and guided teaching experiences emphasize developmentally appropriate instructional planning, assessment (formal and informal), classroom management and communication. This course incorporates technology into student assignments, requires at least 20 hours of field experience, and includes advanced readings and assignments linking theory (classroom) to practice (field experience). (Fall)

412. Elementary General Music Methods
6MUE 412 (I-2) Elementary General Music Methods: This course is designed to prepare students for teaching general music to all elementary age students, regardless of socioeconomic status or ability, in our diverse American society. Examines factors in the home, community, and school that affect students’ readiness to learn music and links language literacy with musical literacy through singing, creating, moving, and listening activities. Observation and guided teaching experiences emphasize instructional planning, assessment (formal and informal), classroom management and communication. Reflective assignments for the teaching portfolio are encouraged. This course incorporates technology into student assignments, requires at least 20 hours of field experience, and includes advanced readings and
assignments linking theory (classroom) to practice (field experience). (Fall)

413. Secondary General Music Methods
6MUE 413 (II-2) Secondary General Music Methods: This course is designed to prepare students for teaching general music to all secondary age students, regardless of socioeconomic status, ability, or previous musical experience. Examines the importance of music education to an educated citizenry. Technology for music composition and music production is incorporated throughout. Observation and guided teaching experiences emphasize age-appropriate communication and classroom management as well as instructional planning and assessment (formal and informal). Reflective assignments for the teaching portfolio are encouraged. At least 20 hours of field experience as well as advanced readings and assignments linking theory (classroom) to practice (field experience) are required. (Fall Spring)

414. Elementary and Middle School Choral Methods
6MUE 414 (II, 2) Elementary and Middle School Choral Methods: In this course, preservice teachers will develop increased proficiency with musical repertoire, curriculum design, differentiated instruction, classroom management and communication in vocal music classrooms with students in grades 4-8. Extensive observation and teaching experiences take place in inclusive vocal music classrooms where assistive technology is frequently employed. In the classroom, preservice teachers have opportunities to see how parents, teachers, professional staff, and administrators interact productively to enhance student learning. Reflective assignments for the teaching portfolio are encouraged. At least 25 hours of field experience as well as advanced readings and assignments linking theory (classroom) to practice (field experience) are required. (Spring)

415. High School Choral Music
6MUE 415 (I-2) High School Choral Music: In this course, preservice teachers will develop increased proficiency with musical repertoire, curriculum design, differentiated instruction, classroom management and communication in vocal music classrooms with students in grades 9-12. This course requires at least 45 hours of extensive observation and supervised teaching in a high school classroom, where preservice teachers have opportunity to interact with teachers, professional staff, parents and administrators to enhance the music learning of high school students. Advanced readings and assignments linking professional development site experience to educational theory are required. Video recording, reflective analysis and subsequent modification of all supervised teaching episodes in the field are also required. (Fall)

419. Secondary Instrumental Rehearsals: Winds, Brass, Percussion
MUE 419 (I, II-2) Secondary Instrumental Rehearsals: Winds, Brass, Percussion: This course allows pre-service teachers to develop an understanding of research-validated, appropriate methods for teaching secondary instrumental music, and to develop the necessary techniques to implement those methods. Course requirements include making long and short range instructional plans based on systematic analysis of individual and ensemble performance, teaching individual and small group lessons, rehearsing and conducting small and large ensembles. Assignments incorporate use of music composition and production technologies. Through at least 20 hours of field experience, pre-service teachers have opportunities to interact with teachers, professional staff, parents and administrators to enhance the music learning of secondary school students and learn appropriate communication, and assessment (formal and informal) techniques. Advanced readings and assignments linking theory (classroom) to practice (field experience) are required. (Fall Spring)

420. Secondary Instrumental Rehearsals: Strings
6MUE 420 (II-2) Secondary Instrumental Rehearsals: Strings: This course allows preservice teachers to develop an understanding of research-validated, appropriate methods for teaching secondary instrumental music, and to develop the necessary techniques to implement those methods. Course requirements include making long and short-range instructional plans based on a systematic analysis of the performance of individuals and the ensemble, teaching private and small group lessons, rehearsing and conducting the large ensemble. Through a minimum of 20 hours of field experience, preservice teachers have opportunity to interact with teachers, professional staff, parents and administrators to enhance the music learning of high school students and learn age-appropriate classroom management, communication, and assessment (formal and informal) techniques. Video recording, reflective analysis and subsequent modification of all supervised teaching episodes in the field are required. (revised 10/14/08) (Spring)

465. Instrumental Methods and Techniques: Wind and Percussion
6MUE 465 (I, S-3) Instrumental Methods and Techniques: Wind and Percussion: For instrumental, vocal, and general music teachers at all levels who wish to improve their musicianship skill for teaching, this course emphasizes innovative ways to address State and National Standards in Music and appropriately differentiate music instruction. The principles of music literacy acquisition and language acquisition are compared. Assignments incorporate the use of music composition and production technologies. Twenty-five (25) hours of field experience are required for students pursuing Initial-Professional Certification. (Fall Summer)

466. Instrumental Methods and Techniques: Strings
6MUE 466 (I, S-3) Instrumental Methods and Techniques: Strings: For instrumental, vocal, and general music teachers at all levels who wish to improve their musicianship skill for teaching, this course provides an orientation to the design and implementation of string programs, with emphasis on developing age appropriate instructional strategies, classroom management,
communication and assessment (formal and informal) for heterogeneous groups. The principles of music literacy acquisition and language acquisition are compared. Video recording, reflective analysis and subsequent modification of all supervised teaching episodes in the field are required. Assignments incorporate the use of music composition and production technologies. 15 hours of field experience are required for students pursuing Initial-Professional Certification. (Fall Summer)

471. Teaching Internship

6MUE 471 (I, II-2) Teaching Internship: Students are required to demonstrate competence in teaching and the application of concepts presented in other courses required by the M.M. or M.A. degrees in music education by submitting the following: (1) audio and video tapes of classes, (2) course descriptions and outlines, (3) sample examinations, (4) an annual calendar of performances and activities, and/or (5) sample programs. Students who are also employed as teachers can submit materials developed for their own classes; full-time graduate students are assigned a teaching responsibility to complete the requirements under faculty supervision. Readings are assigned individually. This requirement may be satisfied in one of the following ways: (1) one-on-one with a music education faculty member; (2) collaborative teacher study group; (3) review of a substantial portfolio documenting teaching competence. (Fall Spring)

472. Teaching Internship for Certification

6MUE 472 (I, II-4) Teaching Internship for Certification: Supervised teaching experience for graduate students preparing for certification. Includes seminar. (Fall Spring)

473. MA Project

6MUE 473 (I, II, S-1-4) M.A. Project: The specific nature of this master's project will be developed in consultation with a faculty member in the Music Education Department. Guidelines are available in the department for project proposals, which must be approved by the faculty. Examples might include (a) a field-based research study within a teacher's own classroom setting, (b) a curriculum project, or (c) a small-scale replication of an existing research study with a new population. At the completion of the project, a student will submit a written report, again subject to approval by the entire faculty. Please see Guidelines for Field Project for complete information. Parallel to the registration for thesis credits, the registration for this master's project may be broken down into single credits or enrolled as a block of four credits. (Fall Spring Summer)

481. Special Topics in Music Education

6MUE 481 (I-1-3) Special Topics in Music Education: Designed primarily for graduate students, these courses offer intensive study of limited topic areas in music education and pedagogy. May be repeated for credit. (Fall)

482. Special Topics in Music Education

6MUE 482 (II-1-3) Special Topics in Music Education: Designed primarily for graduate students, these courses offer intensive study of limited topic areas in music education and pedagogy. May be repeated for credit. (Spring)

483. Special Topics in Music Education

6MUE 483 (I, II - 1-3) Special Topics in Music Education: Designed primarily for graduate students, these courses offer intensive study of limited topic areas in music education and pedagogy. May be repeated for credit. (Fall Spring)

490. Independent Study

495. MA Thesis

6MUE 495 (I, II, S-credit to be arranged) M.A. Thesis: For the Master of Arts degree. (Fall Spring Summer)

501. History & Philosophy Seminar

6MUE 501 (I, S-3) History and Philosophy Seminar: Philosophy and history of music education, with emphasis on contemporary problems. Required of all graduate students in music education. (Fall Summer)

502. Curriculum Seminar

6MUE 502 (II, S-3) Curriculum Seminar: Inquiry into curriculum theory and creative curriculum development and implementation. Attention is devoted to how schools are organized, how processes and outcomes of learning are evaluated, and how conditions can be created to foster professional growth among music teachers and administrators. (Spring Summer)

503. College Teaching Internship

6MUE 503 (I, II-2) College Teaching Internship: This course will be related to one or more college level courses which the student is presently teaching, either as a teaching assistant or as a faculty member at another college or university. Students will be required to submit (1) a course description, (2) a course outline, (3) tests and examinations, (4) an annotated bibliography, (5) audio tapes of classes, and (6) a brief written statement of relevant philosophical and pedagogical issues. The instructor will observe teaching and meet with the students individually. (Fall Spring)

504. Preparing Future Music Faculty

6MUE 504 (I-2) Preparing Future Music Faculty: This course will prepare those graduate students who desire to teach in a college or community music school, even on a part-time basis. Each student will learn to develop a teaching portfolio that will complement his or her performance portfolio. Students will also explore ways to organize music content for learning, assess students' prior musical knowledge and experience, communicate expectations to students, and speak knowledgeably about teaching with colleagues and administrators. Cross-listed as ALC 422 and ALC 422. (revised 11/11/11) (Fall)
505. Seminar in Academic Administration
6MUE 505 (I-3) Seminar in Academic Administration: Topics and issues related to music administration in school, community, and higher education settings. (Fall)

506. Internship in Academic Administration
Prerequisite: MUE 505.
6MUE 506 (II-1-2) Internship in Academic Administration: Administrative project, to be carried out under supervision of faculty or administrative staff member, including possible assignment to a School administrative office. Occasional seminar sessions with other enrollees. (Spring)

508. Cultural Perspectives in Music Education
6MUE 508 (II-3) Cultural Perspectives in Music Education: This course focuses on fundamental issues that affect the teaching and learning of music in our culturally pluralistic American society. It is a survey and critical study of historical, philosophical, and sociological aspects of multicultural music education. It is designed to provide opportunities for graduate students to develop thinking, inquiry, writing, and oral presentation skills necessary for perceptive and competent music educators. In addition, this course is intended to provide opportunities for graduate students to synthesize various components of music education scholarship. This course is addressed to all Eastman DMA and Ph.D. students in Music Education. Others with teaching experience will be admitted with the permission of the instructor. (Spring)

590. Independent Study
591. Research for DMA Students
6MUE 591 (I, II, S-credit to be arranged) Research for D.M.A. Students (Fall Spring Summer)

595. PhD Dissertation Project
6MUE 595 (I, II, S-credit to be arranged) PhD Dissertation Project: For the Doctor of Philosophy degree. (Fall Spring Summer)

596. DMA Dissertation Project
6MUE 596 (I, II, S-credit to be arranged) DMA Dissertation Project: For the Doctor of Musical Arts degree. (Fall Spring Summer)

501. Introduction to Musicology
6MUY 501 (I-4) Introduction to Musicology: This course will provide an introduction to the scope, bibliography, and prominent methodologies of musicology. To that end, it will explore the history and development of the discipline, focusing especially on the current trends and their background: provide a practical introduction to the diverse sources of information in the field; and give experience employing solid research and writing strategies. (Fall)

502. Introduction to Ethnomusicology
6MUY 502 (II-4) Introduction to Ethnomusicology: This course charts the genealogies of thought over the last several centuries that inform our contemporary understanding of ethnomusicology. It will provide a historical overview of the field, highlighting many of the important figures and works that have marked the discipline’s history and have led to shifts in the way ethnomusicologists understand the relationship of music, society, and culture. We will explore what it is that an ethnomusicologist does (or once did) by studying a variety of approaches to fieldwork methods and ethnographic representation. We will explore several theoretical orientations—drawing from the disciplines of anthropology, linguistics, performance theory, media studies, and philosophy—that inform the work of past and present ethnomusicologists, and introduce a range of musical styles, practices, and ways of thinking about sound in different parts of the world through the study of select musical ethnographies. (Spring)

590. Research
6MUY 590 (I, II-credit to be arranged) Research: Independent investigation of problems in musicology. This course number is used by MM and DMA students enrolling in MUY 4-credit seminars for 3 credits. (Fall Spring)

591. Seminars in Musicology and Ethnomusicology
6MUY 591 (I-4) Seminars in Musicology and Ethnomusicology: Topics will vary by semester. Recent offerings include: Chansonniers, Opera in 17th-century Venice, Music and the Cold War, Mode in Balinese Music; The Motet before 1360; Illuminated Music Manuscripts; Josquin and his Contemporaries; Early Music Analysis pre-1600; The 17th-century Italian Cantata; Romantic Criticism and Aesthetics; National Styles & Exoticism, 1600-2006; 19th century Italian Opera; Voice and Spectacle: Stage to Screen, 1880-1930; Kurt Weill and his Contemporaries; Sondheim; Postmodernism; Music and Ritual; as well as occasional seminars taught or co-taught by noted scholars from other departments at Eastman and in the College of the University of Rochester. (Fall)

592. Seminars in Musicology and Ethnomusicology
6MUY 592 (I, II-4) Seminars in Musicology and Ethnomusicology: Topics will vary by semester. Recent offerings include:
Chansonniers, Opera in 17th-century Venice, Music and the Cold War, Mode in Balinese Music; The Motet before 1560; Illuminated Music Manuscripts; Josquin and his Contemporaries; Early Music Analysis pre-1600; The 17th-century Italian Cantata; Romantic Criticism and Aesthetics; National Styles & Exoticism, 1600-2006; 19th century Italian Opera; Voice and Spectacle: Stage to Screen, 1880-1930; Kurt Weill and his Contemporaries; Sondheim; Postmodernism; Music and Ritual; as well as occasional seminars taught or co-taught by noted scholars from other departments at Eastman and in the College of the University of Rochester. (Spring)

593. Directed Study I
6MUY 593 (I-4) Directed Study I: Required of Ph.D. candidates in Musicology (and can be taken only by them). Prerequisites: Successful completion of Qualifying Exam or special approval of chair. (Fall)

594. Directed Study II
6MUY 594 (II-4) Directed Study II: Required of Ph.D. candidates in Musicology (and can be taken only by them). Prerequisite: MUY 593. (Spring)

595. PhD Dissertation Project
6MUY 595 (I, II, S-credit to be arranged) PhD Dissertation Project (Fall Spring Summer)

OBOE (OB)

430. Sec Oboe
430 (I, II-15) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Oboe
430A (I, II-5) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Oboe
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

590. Baroque Oboe Studies
OB 590 (I, II-1) Baroque Oboe Studies Goals: to develop familiarity with 18th-century oboes and performance practice. Students use Eastman’s extensive range of baroque and classical oboes, collected by Prof. Killmer. Activities include technical studies, reed making, solo sonatas, chamber music, collaboration with keyboard and organ students, and oboe band. 6 hour private lessons plus ensemble and group work to be arranged with instructor. (Fall Spring)

OPERA (OP)

401. Seminar in Lyric Theater Stage Directing
6OP 401 (I, II-2) Seminar in Lyric Theater Stage Directing: Study and practice of lyric theater stage direction. Stage terminology, stage design concepts, the study of historical directors and acting teachers, stage management principals, arts management, preparing a conceptual proposal for a design team and staging a scene are components covered within the course. Opera 401 and 402 may be repeated for additional credit. (Fall Spring)

402. Seminar in Lyric Theater Stage Directing
6OP 402 (I, II-3) Seminar in Lyric Theater Stage Directing: Study and practice of lyric theater stage direction. Stage terminology, stage design concepts, the study of historical directors and acting teachers, stage management principals, arts management, preparing a conceptual proposal for a design team and staging a scene are components covered within the course. Students are required to assist in the direction of Opera Theatre productions or direct a scene in the opera workshop. Opera 401 and 402 may be repeated for additional credit. (Fall Spring)

410. Opera Production Project: Stage Management
6OP 410 (I, II-2) Opera Production Project-Stage Management: Study of basic concepts and procedures relevant to an opera stage manager. Students are required to participate as assistant stage managers for the Opera Theatre productions. Prerequisites: 2 semesters of OP 209, 210; 2 semesters OP 211-214; and/or permission of instructor. (Fall Spring)

412. Opera Workshop: for Graduate Students
6OP 412 (II-1) Opera Workshop: For Graduate Students: This course follows the same description as the Opera Workshop 212 course. Permission of primary voice teacher and instructor required. (Spring)

413. Early American Lyric Theater Survey and Performance Practicum
6OP 413 (I, II-1) Early American Lyric Theater Survey and Performance Practicum: A study of early American Musical Theater and American Operetta. The survey will include a study of the ‘Princess Theater Musicals,’ with emphasis given to the collaborative works of Jerome Kern, P. G. Wodehouse and Guy Bolton. Works by Rodgers & Hart and early Cole Porter will also be studied. A survey of American Operetta will include works by
Victor Herbert and Sigmund Romberg. Students will sing ballads and ensembles from the shows covered within the course. The course will culminate in a performance of a scenes program or musical review of the works studied in the class. Prerequisites: 2 semesters of OP 209, 210; and/or permission of instructor. Offered every other year. (Fall Spring)

414. Fundamentals for the Singer-Actor

6OP 414 (I-1) Fundamentals for the Singer-Actor: Offered in the fall semester. Offered to Graduate students only. This course explores specific forms in lyric theater through study, exercise and execution (The recitative, the aria, scene work, opera, musical theater). Stage terminology, exploration of acting methods, analyzing text, character development, monologues. Exercises exploring body awareness (self & group) and techniques that aid coordinated movement within an ensemble. Can be used as elective credit. It is strongly encourage that graduates students register for this class during their first semester. Prerequisite: none (Fall)

415. Opera Repertoire

6OP 415 (I-1) Opera Repertoire: The practical study of operatic literature from Mozart to the present day through the musical preparation of arias and scenes appropriate for the enrollment. Specific attention is given to historic performance practice and the unique challenges of the lyric theater: stylistic interpretation of accompanied and secco recitative, the basics of vocal ornamentation as it applies to the stage, musical/ dramatic score analysis, etc. (Offered in the fall semester concurrently with OP 405 for pianists and designed to musically prepare singers for OP 416 in the spring semester.) Prerequisite: permission of instructor and voice teacher. May be repeated for credit. (Fall)

416. Advanced Opera Seminar: Performance Techniques

6OP 416 (I-2) Advanced Opera Seminar-Performance Techniques: The study, preparation, and performance of arias and excerpts from operatic literature. Through historical research, character analysis, and dramatic staging, the student prepares excerpts and arias from the OP 415 class for public performances. Special attention given to the preparation of arias for professional auditions. Prerequisites: 2 semesters of OP 209, 210; 2 semesters OP 211-214; and/or permission of instructor. (Fall)

430. ESM Opera Theater Practicum

6OP 430 (I, II-1) ESM Opera Theater Practicum: Offered in both the fall and spring semester. Credit given to an undergraduate student for opera main stage production. Leads and chorus receive equal 1 hr. credit for participation and successful completion. An undergraduate student cast in an opera may register for this course at any point in their degree track. Graduate students cast in the spring opera may only use the credit of this course for main stage opera participation. (Fall Spring)

432. Opera Theatre Practicum-Scen

6OP 432 (II-1) Opera Theatre Practicum-Scenes: Offered in the spring semester. This course will be offered to second semester seniors and Graduate students interested in the course who have not been cast in the Spring production. Undergraduate students cast in a second main stage opera fulfill this credit. For undergraduate students who have not been cast in a second opera, this course will function as an additional performance project. Combined with graduate students who will be taking this course as an elective credit (not for participation in the opera), the course will focus on selected scenes and/or chamber works (depending on the available singers) presented in a workshop setting. (Spring)

490. Independent Study

590. Independent Study

ORGAN (ORG)

430. Sec Organ

430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Organ

430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring Summer)

460. Primary Organ

460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)
460A. Primary Organ
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week); Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

PEDAGOGY (PED)

405. Descriptive & Analytical Writing in Jazz
6PED 405 (I-1) Descriptive & Analytical Writing in Jazz: The course is designed to sharpen the writing skills of MM/JCM students, so that they will be better equipped to deal with the writing assignments of PED 406. DMA/JCM students who are not native English speakers, or whose writing skills are deficient may take this course as an elective. (Fall)

406. Graduate Jazz Pedagogy
Prerequisite: MM JCM major or permission of instructor.
PED 406 (I-2) Graduate Jazz Pedagogy: Philosophical justification and outcome expectations for the school jazz studies program; profiles of established programs in institutions of various sizes; pedagogical discussions pertaining to the teaching of jazz improvisation, theory, history, composition/arranging, and ensembles; development of the curriculum vitae and job application preparation; preparation for the professional interview. (Fall)

420. Pedagogy of Accompanying
6PED 420 (I-2) Pedagogy of Accompanying: Establishing and administering courses or degree programs in sight reading and accompanying; basic curricula and materials; required reading; observations; creation of CV, bio and repertoire lists. Prerequisite: permission of instructor. (Fall)

421. Pedagogy of Accompanying
6PED 421 (II-2) Pedagogy of Accompanying: Required reading continues; observations continue; business aspects; possibility of some supervised teaching experience. Prerequisite: permission of instructor and PED 420. (Spring)

431. String Pedagogy & Literature I
6PED 431 (I-2) String Pedagogy and Literature I: For graduate students in string performance who wish to teach in private studio settings. Topics covered will vary, but will include: beginning to advanced sequenced music literature, various string teaching methods, evolution of the instrument’s technique over the past two-and-a-half centuries through players and composers, physical aspects of playing and its evolution. (Fall)

432. String Pedagogy & Literature II
6PED 432 (II-2) String Pedagogy and Literature II: For graduate students in string performance who wish to teach in private studio settings. Topics covered will vary, but will include: beginning to advanced sequenced music literature, various string teaching methods, evolution of the instrument’s technique over the past two-and-a-half centuries through players and composers, physical aspects of playing and its evolution. (Spring)

433. History of String Instruments, Players & Pedagogues
6PED 433 (II-2) History of String Instruments, Players and Pedagogues: This course is designed for graduate students in string performance who wish to teach their instrument. Topics covered will include a history of the instruments and their development over the past 400 years; instrument and bow makers and their innovations; famous performers and their repertoire; developments in technique over the years; and contributions of famous pedagogues. (Spring)

435. History of Percussion
6PED 435 (I-2) History of Percussion: “Percussion is to be understood backwards but it must be played forward.” The history of percussion course is designed to provide historical knowledge of the major events in the development of percussion from the beginning to the present with a look at the future. (Fall)

440. Survey of Child’s Musical Development
6PED 440 (I,2) Survey of Child’s Musical Development: Overview of pertinent methods and teaching aids from a child’s early years through High School that would help to provide a solid basis for the developing music student, as well as knowledge to aid the teacher or parent guiding this student. (Fall)

451. Renaissance Lute Literature and Pedagogy
6PED 451 (I-2) Renaissance Lute Literature and Pedagogy: Literature and pedagogy for lute and other plucked instruments from the fourteenth through the sixteenth centuries. Works will be performed from original sources in French, Italian, Neapolitan, and German tablature, as well as mensural notation in all clefs. Major treatises of the period will be studied and the playing techniques and performance practices explored. Offered alternate years.(rev. 9/16/08) (Fall)

452. Baroque Lute Literature and Pedagogy
6PED 452 (II-2) Baroque Lute Literature and Pedagogy: Literature and pedagogy for lute, archlute, theorbo, and Baroque guitar in the seventeenth and eighteenth centuries. Works will be performed from original sources in French and Italian tablature, and guitar alfabeto, as well as from mensural notation in all clefs. Major treatises of the period will be studied and the playing techniques and performance practices explored. Offered alternate years.(rev. 9/16/08) (Spring)

461. Graduate Practical Piano Pedagogy
6PED 461 (I-2) Graduate Practical Piano Pedagogy: In addition to the coursework involved in 261-262, graduate students would be responsible for one of the following: • in-depth analysis of current piano pedagogy curricula in various music-school degree programs • creation of a pedagogy syllabus for one semester,
and two semesters sequences • construction of a personal teaching philosophy • thorough examination of web sites devoted to piano pedagogy • the Independent studio teacher: Professional Studio Documents, Office Technology, The Art of Performance, Setting Rates, Studio Recitals, Tuition and Payment Plans, Composition and Improvisation, Marketing, Communications with Parents, Make-up Policies, Zoning and Business Licenses, Teaching Materials and Learning Styles, The Art of Practice, Arts Funding. (Fall)

462. Graduate Practical Piano Pedagogy

6PED 462 (I-2) Graduate Practical Piano Pedagogy: In addition to the coursework involved in 261-262, graduate students would be responsible for one of the following • in-depth analysis of current piano pedagogy curricula in various music-school degree programs • creation of a pedagogy syllabus for one semester, and two semesters sequences • construction of a personal teaching philosophy • thorough examination of web sites devoted to piano pedagogy • the Independent studio teacher: Professional Studio Documents, Office Technology, The Art of Performance, Setting Rates, Studio Recitals, Tuition and Payment Plans, Composition and Improvisation, Marketing, Communications with Parents, Make-up Policies, Zoning and Business Licenses, Teaching Materials and Learning Styles, The Art of Practice, Arts Funding. (Spring)

471. Teaching Internship

6PED 471 (I, II-2) Teaching Internship: This internship is the culminating experience for candidates pursuing the Certificate in Collegiate and/or Community Music teaching. Individual teaching situations are arranged and a faculty supervisor is assigned. Students must show competence in teaching and demonstrate application of concepts presented in the certificate curriculum. Expectations for students include the preparation of a teaching portfolio with (1) audio and video recordings of teaching; (2) course descriptions, outlines, syllabi; (3) sample assessment documents; (4) sample plans for teaching; and (5) written reports of observation by the supervisor. Readings, observations of teaching, and other related experience may also be assigned by the supervisor. (Fall Spring)

481. Principles of Vocal Pedagogy

Prerequisites: PED 281-282, Undergraduate Vocal Pedagogy or its equivalent.

6PED 481 (I-2) Principles of Vocal Pedagogy: Designed to advance the student's knowledge of the structure and function of the vocal mechanism. The class addresses issues of both performance and the teaching of singing. Topics include exploring the relationship of function to artistry, breathing, coordination of vocal process, historic traditions, vocal health/longevity, methods for self-evaluation, performance challenges, teaching skills and studio management. (Fall)

482. Advanced Vocal Pedagogy

Prerequisite: PED 481 or consent of instructor

6PED 482 (II-2) Advanced Vocal Pedagogy: Seminar discussions and practical application of the principles discussed in PED 481 through supervised teaching. Each member of the class will be assigned a student of each gender. A diary will be maintained recording the progress of the student lessons. That diary will be emailed to the instructor at the end of the semester. In addition each student will spend time observing lessons in the studios of all voice faculty other than that of his or her own major professor. (Spring)

490. Independent Study

505. Desc/Analy Writing in Jcm

6PED 505 (I-1) Descriptive & Analytical Writing in Jazz: The course is designed to sharpen the writing skills of MM/JCM students, so that they will be better equipped to deal with the writing assignments of PED 406. DMA/JCM students who are not native English speakers, or whose writing skills are deficient may take this course as an elective. (Fall)

590. Independent Study

PERCUSSION (PRC)

430. Sec Percussion

430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Percussion

430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Percussion

460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)
PERFORMANCE (PRF)

490. Independent Study

590. Independent Study

596. DMA Dissertation Project

6PRF 596 (I, II, S-credit to be arranged) DMA Dissertation Project For Performance & Literature majors. (Fall Spring Summer)

PIANO (PA)

430. Sec Piano

430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week); May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Piano

430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Piano

460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460A. Primary Piano

460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

PICCOLO (PIC)

430. Sec Piccolo

430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week); May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

SACRED MUSIC (SMU)

407. Perspectives in Sacred Music

6SMU 407 (I-2) Perspectives in Sacred Music: These courses focus on the history, function, and future of liturgical music in the Christian Church by examining theological, liturgical, historical, and philosophical issues pertaining to the practice of sacred music. Students will explore both church year and lectionary as contextual parameters for the function of music within the liturgy. The course also includes a comprehensive survey of Christian hymnody. (Fall)

408. Perspectives in Sacred Music

6SMU 408 (II-2) Perspectives in Sacred Music: These courses focus on the history, function, and future of liturgical music in the Christian Church by examining theological, liturgical, historical, and philosophical issues pertaining to the practice of sacred music. Students will explore both church year and lectionary as contextual parameters for the function of music within the liturgy. The course also includes a comprehensive survey of Christian hymnody. (Spring)

410. Schola Cantorum

6SMU 410 (I,II-1) Schola Cantorum: This singing group specializes in Gregorian chant, renaissance polyphony, and choral improvisation, and also performs romantic and contemporary music. Performance practice issues are approached as an aesthetic system of possibilities that generates expressive music making through informed choices. Students expand their listening, reading, and performance skills through rehearsals and subsequent public performance each week, singing the weekly Office of Compline at Christ Church on Sunday evenings at 9:00 p.m. (October through April). Rehearsals are Sunday evenings from 7:30 - 8:45 p.m. (rehearsals begin at 7:00 p.m. on first Sundays of the month) Permission of instructor Stephen Kennedy required following audition. (Fall Spring)

471. Sacred Music Internship

6SMU 471 (I-1) Sacred Music Internship: Students in the internship will normally be employed in a church music position in the greater Rochester area. For those students who do not seek a paid position, placement as an intern in a large, local congregation is required. The internship is intended to provide students with opportunities to apply knowledge and skills under the guidance of faculty members teaching in organ, sacred music, conducting, and music education. The internship may include service playing, directing choirs, administration, and working as a member of a team ministry. Students, with the assistance of the professor of Sacred Music, will set individualized plans/goals of study for the internship. Each student can expect to be observed at least twice per semester by the faculty mentors, and can expect to participate in regular colloquia on current issues in church music. (Fall)
472. Sacred Music Internship

6SMU 472 (II-1) Sacred Music Internship: Students in the internship will normally be employed in a church music position in the greater Rochester area. For those students who do not seek a paid position, placement as an intern in a large, local congregation is required. The internship is intended to provide students with opportunities to apply knowledge and skills under the guidance of faculty members teaching in organ, sacred music, conducting, and music education. The internship may include service playing, directing choirs, administration, and working as a member of a team ministry. Students, with the assistance of the professor of Sacred Music, will set individualized plans/goals of study for the internship. Each student can expect to be observed at least twice per semester by the faculty mentors, and can expect to participate in regular colloquia on current issues in church music. (Spring)

SAXOPHONE (SAX)

430. Sec Saxophone

430 (I, II-1) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Saxophone

430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Saxophone

460 (I, II-1) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Saxophone

460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

STUDY ABROAD (SAB)

400. Study Abroad

6SAB 400 (I, II-12 credits for grad students) The Conservatory Exchange Program enables students to spend a semester or academic year studying at a leading conservatories around the world. Students will receive credit and pay tuition to Eastman, and will not pay tuition to the host school. Requires permission of the Associate Dean of Academic Affairs; apply by February 1 for the following academic year. For information on participating schools, see https://www.esm.rochester.edu/academic-affairs/exchange/. (Fall Spring)

THEORY (TH)

400. Survey of Analytical Techniques

6TH 400 (I, II-3) Analytical Techniques: An introduction to the basic techniques of both tonal and non-tonal repertories designed with the particular needs of the performance major in mind. The course introduces students to a broad range of techniques of analysis and insofar as possible, their implications for performance. Short assignments and papers explore the basic analytical literature and evaluate the results of various analytical techniques. (Fall Spring)

401. Topics in Tonal Literature and Analysis

6TH 401 (I, II-3) Topics in Tonal Literature and Analysis: This course introduces and explores analytical techniques and issues relevant to the traditional tonal musical literature, addressing as well the performance implications of analytical decisions insofar as possible. The course deals with the analysis of various musical dimensions in a core repertoire that will vary from semester to semester. Topics include meter/rhythm, harmonic syntax, motivic structure, deeper-level linear structure, formal processes, and text/music relationships. (Fall Spring)

402. Topics in Non-Tonal Music Literature and Analysis

6TH 402 (I, II-3) Topics in Non-Tonal Music Literature and Analysis: This course introduces and explores a broad range of analytical techniques and issues relevant to non-tonal music. The course deals with the analysis of various musical dimensions in a core repertoire that will vary from semester to semester. Topics include meter/rhythm, harmonic syntax, motivic structure, deeper-level linear structure, formal processes, and text/music relationships. (Fall Spring)

402A. Theory & Analysis in Paris

TH 402A (S-1) Theory and Analysis of Contemporary Music: Study Abroad Course in Paris: This summer study-abroad program is a three-credit, graduate-level course offered in Paris, France, and is open to performers, composers, theorists, and other devotees of new music. In parallel with ManiFeste, a month-long festival of contemporary music produced by IRCAM (Institut de Recherche et Coordination Acoustique / Musique), the course will explore musical innovations of the last
25 years with special emphasis on the composers featured in the festival. This year’s featured composers include Philippe Leroux, Beat Furrer, and Rebecca Saunders. Students will attend course meetings every weekday for the first two weeks, then participate as auditors in the IRCAM Academy for the final two weeks. Academy events include public lectures, masterclasses for composers and interpreters, open rehearsals, and films. (Summer)

404. 18c Keyboard Improvisation

411. Introduction to Theory & Analysis Tonal Music
Prerequisites: at least one upper-level undergraduate form and analysis course. Open to DMA, MM, MA, and qualified undergraduates by permission.

6TH 411 (I-3) Theory and Analysis of Tonal Music: Introduction to the theories of Heinrich Schenker and their application to the analysis of tonal music. Intensive analytical work and selected readings. (Fall)

412. Acoustics
Prerequisite: TH 202. Students who have received credit for TH 212 may not enroll in this course.

6TH 412 (I-3, alternate years) Acoustics: An introductory course in the physical properties of sound, including vibrating systems, wave propagation, room acoustics, tuning and temperament, the psychology of hearing, the physics of musical instruments and the voice, digital synthesis and recording, and computer manipulation of sound. A research paper on an approved topic is required. (Fall)

421. Pedagogy of Theory I

6TH 421 (I, II-3) Pedagogy of Theory I: A course in the materials, organization, techniques, and problems of the first two years of theory teaching, designed for MA Theory Pedagogy (fall) and DMA students (spring). Bibliographical survey of texts and sample teaching. Observation and teaching of freshman and sophomore classes. (Fall/Spring)

422. Pedagogy of Theory II: Advanced Topics

6TH 422 (II-3, alternate years) Pedagogy of Theory II: This course takes up a host of pedagogical topics designed to complement the skills developed in TH 421. Some are more practical in nature (e.g., the pedagogy of musical form, or various uses of technology), while others are more abstract/philosophical (e.g., curriculum design and repertoire selection). Still others are aimed at professional development, like writing a statement of teaching philosophy or preparing for successful job interviews. TH 421 is not a prerequisite. Open to theory majors; others only by permission of instructor. (Spring)

431. Seminar in Analysis & Performance
Prerequisite: TH 400 or the equivalent.

6TH 431 (I, II-3) Seminar in Analysis and Performance: This course deals primarily with the relationship between analysis and performance decisions. It also draws upon the history of performance practice, contemporaneous sources on the subject, and comparative evaluation of recorded performances. Specific works studied are determined by the instructor in consultation with the students. A major analysis of an approved work is required. (Fall/Spring)

441. Computer Applications in Music Research
Prerequisite: A basic familiarity with computers. Students unsure about their level of experience with computers should meet with the instructor before enrolling in this course.

6TH 441 (I, II-3, alternate years) Computer Applications in Music Research: An introduction to computer programming and data mining for music research. Course topics will include object-oriented programming in C++, Java, and Javascript, data structure definition and manipulation, information theory, and topics from computer science and the computer music literature. For TH 441 additional programs and readings beyond the specifications for TH 241 are required. (Fall/Spring)

451. Modal Counterpoint

6TH 451 (I-3) Modal Counterpoint: Study of the practice of sixteenth-century modal counterpoint. Includes development of written skills through species counterpoint, and study of stylistic counterpoint as found in the sacred vocal polyphony of such masters of the period as Palestrina, Victoria, and Lasso. Composition of two-, three-, and four-voice pieces in counter-Reformation style. (Fall)

452. Eighteenth-Century Counterpoint

6TH 452 (II-3) Eighteenth-Century Counterpoint: Study of contrapuntal practice of the mature and late Baroque periods, with emphasis on the style of J.S. Bach. Composition of two-, three-, and four-voice choral preludes, binary dances, inventions, and fugues. (Spring)

460. Music & the Mind

6TH 460 (II-3) Music and the Mind: An introduction to the discipline of music cognition. Topics surveyed include empirical methods, psycho-acoustic principles, influence of Gestalt psychology, music and language, metric and tonal hierarchies, music and the brain, aspects of musical development, and research on musical memory, expectation, and emotion. Lecture and discussion format, with exams and final literature-review research paper. Cross-listed as TH 260. (Spring)

461. Aural Musicianship for Conductors

6TH 461 (I-1, alternate years) MM and DMA conducting students pursue an advanced level of skills both for hearing the building blocks of tonal and post-tonal music, and for practical tasks related to their craft. Particular attention is given to sight singing, transposition, multiple clefs, error detection, and dictation/musical memory. (Fall)
462. Aural Musicianship for Conductors
6TH 462 (II-1, alternate years) MM and DMA conducting students pursue an advanced level of skills both for hearing the building blocks of tonal and post-tonal music, and for practical tasks related to their craft. Particular attention is given to sight singing, transposition, multiple clefs, error detection, and dictation/musical memory. (Spring)

471. Apprenticeship in Pedagogy I
6TH 471 (I-1) Apprenticeship in Pedagogy I: A two-semester student-mentor relationship in which the student will learn first-hand about the workings of the undergraduate curriculum and then design a project. In the first semester, the student will observe each of the undergraduate core courses and keep a journal which reflects self-awareness of pedagogical technique and materials. The student will submit a written summary of each of the c. 25 observations at the end of the semester. Students will sign up concurrently for ESM 470, the Teaching Recital with TH 471. Open only to M.A. in Theory Pedagogy majors. (Fall)

472. Apprenticeship in Pedagogy
Prerequisite: Open only to M.A. in Theory Pedagogy majors.
6TH TH 472 (II-2) Apprenticeship in Pedagogy II: A two-semester student-mentor relationship in which the student will learn first-hand about the workings of the undergraduate curriculum and then design a project. In the second semester, the student will create, design, and craft an original project that focuses on some pedagogical aspect of the written or aural curricula. Open only to M.A. in Theory Pedagogy majors. (Spring)

475. Intermediate Keyboard Skills
Prerequisites: TH 202 or equivalent and Piano 104 proficiency; or permission of instructor.
6TH 475 (I-3) Intermediate Keyboard Skills: Practical experience in score reading, figured bass realization, transposition, melody harmonization, and pop symbols. All students are expected to perform weekly assignments at the keyboard. (Fall)

476. Advanced Keyboard Skills
Prerequisites: TH 475 or equivalent. An audition with the instructor, to be scheduled during the first week of spring semester, is required of all students. Instructor’s permission required.
6TH 476 (II-4) Advanced Keyboard Skills: Intensive practical experience in the realization of figured bass, score reading with emphasis on C-clefs, transposition, modulation, and improvisation. All students are expected to perform weekly assignments at the keyboard. (Spring)

480. Model Composition
6TH 480 (I-1) Model Composition. This course focuses on composition in common-practice styles and genres. Projects may include a minuet for string quartet, a Romantic-style character piece for piano, and a Romantic Lied. Open to graduate students and undergraduate theory majors; non-theory undergraduates may take the course with instructor permission. (Fall)

481. Special Topics in Music Theory
6TH 481 (I-3) Special Topics in Music Theory: A variety of analytical and theoretical topics of changing focus. Specific topics and instructors to be announced in advance. May be repeated for credit. (Fall)

482. Special Topics in Music Theory
6TH 482 (II-1) Special Topics in Music Theory: A variety of analytical and theoretical topics of changing focus. Specific topics and instructors to be announced in advance. May be repeated for credit. (Spring)

490. Independent Study

511. Introduction to Theory & Analysis Tonal Music
Prerequisites: At least one upper-level undergraduate form and analysis course.
6TH 511 (I-4) Theory and Analysis of Tonal Music: Introduction to the theories of Heinrich Schenker and their application to the analysis of tonal music. Intensive analytical work and selected readings. Preference given to Ph.D. Candidates; MA, MM, and DMA candidates should take TH411. (Fall)

513. Introduction to the Theory & Analysis of 20th Century Music
6TH 513 (II-4) Theory and Analysis of 20th and 21st-Century Music: This course includes analysis and selected readings. Topics include cyclic, set, serial and twelve-tone, contour, and transformational theories. (Spring)

520. Proseminar in Analysis of Early Music
Prerequisite: TH 401 or TH 511 or permission of instructor.
6TH 520 (II-4, alternate years) Proseminar in Analysis of Early Music: Study and application, in seminar format, of analytical techniques appropriate to the music of the fourteenth through the early seventeenth centuries. Includes critical discussion of analytical methodologies, selective survey of the analytical literature, and analysis of representative composers from the Ars Nova to Monteverdi. Knowledge of music history and literature of this period is presumed. Familiarity with techniques of linear analysis is desirable. Weekly reading assignments, analytical assignments, class presentations, research paper. (Spring)

521. Pedagogy of Theory I
Prerequisites: Preference given to Ph.D. Candidates; MA, MM, and DMA candidates should take TH421.
6TH 521 (I, II-4) Pedagogy of Theory I: A course in the materials, organization, techniques, and problems of the first two years of theory teaching, designed for PhD theory students. Bibliographical survey of texts and sample teaching. Observation and teaching of freshman and sophomore classes. (Fall Spring)
522. Pedagogy of Theory II: Advanced Topics
Prerequisite: TH 421 is not a prerequisite. Open to theory majors; others only by permission of instructor.
6TH 522 (II-3, alternate years) Pedagogy of Theory II: This course takes up a host of pedagogical topics designed to complement the skills developed in TH 421. Some are more practical in nature (e.g., the pedagogy of musical form, or various uses of technology), while others are more abstract/philosophical (e.g., curriculum design and repertoire selection). Still others are aimed at professional development, like writing a statement of teaching philosophy or preparing for successful job interviews. (Fall Spring)

523. History of Music Theory, Part I
6TH 523 (I-4) History of Music Theory, Part I: Part I of a two-semester survey of the history of music theory. The semester will start with the ancient Greeks and end in the early 18th century, covering such topics as division of the pitch continuum, consonance and dissonance, rhythm/meter, mode/scale, counterpoint, and figured bass. (Fall)

524. History of Music Theory, Part II
6TH 524 (II-4) History of Music Theory, Part II: Part II of a two-semester survey of the history of music theory. The semester will start with early 18th century theory and end in the early 20th century, covering such topics as counterpoint, figured bass, functional harmony, tonal form, acoustics, Schenker, and chromaticism. (Spring)

531. Seminar in Analysis & Performance
Prerequisite: TH 400 or the equivalent.
6TH 531 (I, II-4) Seminar in Analysis and Performance: This course deals primarily with the relationship between analysis and performance decisions. It also draws upon the history of performance practice, contemporaneous sources on the subject, and comparative evaluation of recorded performances. Specific works studied are determined by the instructor in consultation with the students. A major analysis of an approved work is required. (Fall Spring)

541. Computer Applications in Music Research
Prerequisite: A basic familiarity with computers. Student unsure about their level of experience with computers should meet with the instructor before enrolling in this course.
6TH 541 (I, II-4, alternate years) Computer Applications in Music Research: An introduction to computer programming and data mining for music research. Course topics will include object-oriented programming in C++, Java, and Javascript, data structure definition and manipulation, information theory, and topics from computer science and the computer music literature. For TH 541, additional programs and readings beyond the specifications for TH 441 are required. (Fall Spring)

542. Proseminar in Computer Applications
Prerequisite: TH 441 or permission of instructor.
6TH 542 (I-4, alternate years) Proseminar in Computer Applications: Topics in object-oriented programming with Java or C++. Stacks, Queues, and Graphs; searching and sorting techniques; recursive algorithms; linked data structures; advanced music coding languages; and more sophisticated applications in theory, musicology, and composition. A substantial final programming project is required. (Fall)

560. Proseminar in Music Cognition
6TH 560 (I, II-4, alternate years) Proseminar in Music Cognition: This seminar in music cognition is intended for graduate students in music theory or cognitive science; others only with permission of instructor. We will survey primary sources in the field on the perception of key, meter, harmony, rhythm, and form. Other topics may include emotion, performance, development, computational modeling, corpus research, and neuroscience. Some topics in experimental methods and statistics will also be covered. Students are required to do a final project and presentation, based on an experiment, computational or corpus research, or a critical survey of a research area. (Fall Spring)

581. Theory Seminar
Prerequisite: permission of instructor.
6TH 581 (I-4) Theory Seminar: Seminar discussion and research into theoretical topics at the doctoral level. Subjects covered change from year to year, depending upon the mutual interests of faculty and students. Exploration of recent developments and articles in the area of theory. (Fall)

582. Theory Seminar
Prerequisite: permission of instructor.
6TH 582 (II-4) Theory Seminar: Seminar discussion and research into theoretical topics at the doctoral level. Subjects covered change from year to year, depending upon the mutual interests of faculty and students. Exploration of recent developments and articles in the area of theory. (Spring)

583. Theory Seminar
Prerequisite: permission of instructor.
6TH 583 (I-4) Theory Seminar: Seminar discussion and research into theoretical topics at the doctoral level. Subjects covered change from year to year, depending upon the mutual interests of faculty and students. Exploration of recent developments and articles in the area of theory. (Spring)

584. History of Theory II
Prerequisite: permission of instructor.
6TH 584 (II-4) Theory Seminar: Seminar discussion and research into theoretical topics at the doctoral level. Subjects covered change from year to year, depending upon the mutual interests of faculty and students. Exploration of recent developments and articles in the area of theory. (Spring)
590. Independent Study

591. Theory Colloquium
6TH 591 (I, II-1) Theory Colloquium: Attendance and participation in Department colloquia. (Fall Spring)

595. PhD Dissertation Project
6TH 595 (I, II, S-credit to be arranged) PhD Dissertation Project (Fall Spring Summer)

TROMBONE (TBN)

430. Sec Trombone
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Trombone
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Trombone
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Trombone
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

TUBA (TBA)

430. Sec Tuba
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Tuba
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Tuba
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Tuba
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

UNIDENTIFIED DEPARTMENT: AMU (AMU)

430. Graduate Applied Lesson
430 (S-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirement, except for MM Conductors who are required to take 4
credits of applied music. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Summer)

430A. Graduate Applied Lesson: performance

430A (S-2) Graduate Applied Music Lessons (half-hour/week): Half-hour lessons in your primary instrument major may be taken only with permission of the Associate Dean for Graduate Studies. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Summer)

UNIDENTIFIED DEPARTMENT: INS (INS)

400. Appalachian Mount Dulcimer
401. ESM New Bassoon Workshop
402. Measurement & Evaluation
403. Introduction to Research
404. Adv Choral Conducting
405. ESM Intl Guitar Masterclass
407. ESM Summer Tuba/Eup Inst
408. The Artistic Flutist
410. Alumni Organists Retreat
412. Entrepreneurial Thinking
415. Performance Anxiety Wrkshp
417. ESM Cello Institute
420. Introduction to Jazz History
421. Website Construction I
422. Measurement & Evaluation
423. Instr Method & Techniques:nc
424. Orch Conducting Fundamentals
425. Summer Conducting Institute
427. Choral Artistry:nc
428. Making Kid Performances Rock
429. Intro to Film Scoring
430. Intro Classical Indian Music
431. 18c Keyboard Improvisation
432. Summer Academy Hs Organists
433. Plays Well With Others
434. Advanced Conservation
435. Melharmony Workshop
436. Singing Gregorian Chant
438. Orff Schulwerk: Level I
441. Practical Harpist
442. African Drumming:nc
444. Orff Schulwerk: Level II:nc
449. Schubert to Sondheim
451. ESM Trumpet Retreat: Meals
452. Orff Schulwerk: Level III
454. ESM Summer Trombone Inst
455. ESM Summer Trumpet Inst
456. Dalcroze Eurhythmics
457. Musikinesis
458. Practical Vocal Pedagogy
465. Intermediate Violinist
467. Eastman Viola Workshop
477. Organ Improvisation
481. Gamelan Ensemble Workshop
482. Percussion Workshop:nc
483. ESM Saxophone Institute
484. ESM Guitar Master Classes
485. American Saxophone Academy:nc
490. Phrase Rhythm/Form in Brahms
501. History & Philosophy of MUE
UNIDENTIFIED DEPARTMENT: RUS (RUS)

415. Russian Diction
6RUS 415 (I, II-1) Russian Diction: This class is designed to give seniors and graduate students a comprehensive approach to pronouncing and singing in Russian. Throughout the semester we will examine the IPA symbols proper to Russian Diction as well as study vital rules of phonetic transcription. We will apply the theoretical material by working on the texts of various songs and arias. (Fall Spring)

VIOLA (VLA)

430. Sec Viola
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Viola
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Violin
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Violin
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

VIOLONCELLO (VCL)

430. Sec Cello
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring Summer)

430A. Prl 1/2 Hr Cello
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring Summer)

460. Primary Cello
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Cello
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)
VOICE (VCE)

430. Sec Voice
430 (I, II-1.5) Graduate Applied Music Lessons (half-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by the degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

430A. Prl 1/2 Hr Voice
430A (I, II-2) Graduate Applied Music Lessons (half-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2.5 credits per semester. (Fall Spring)

460. Primary Voice
460 (I, II-3) Graduate Applied Music Lessons (one-hour/week): May be used as secondary instrument elective credit or as part of a DMA minor. May not be used to fulfill major lesson requirements, unless specifically required by degree program. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 2 credits per semester. (Fall Spring)

460A. Primary Voice
460A (I, II-4) Graduate Applied Music Lessons (one-hour/week): Used to fulfill primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry 5 credits per semester. (Fall Spring)

VOICE CLASS (VCC)

402. Voice Repertoire for Pianist
6VCC 402 (I, II-1) Voice Repertoire for Pianists: An in-depth examination of specific areas of the vocal non-operatic repertoire, including such topics as Baroque style and ornamentation, twentieth-century repertoire, musical settings of a particular poet, comparative settings of the same poem(s), & neglected repertoire. The class meets concurrently with VCC 431 or VCC 432 & addresses the repertoire from the dual perspective of singer & pianist. Required of master's degree students majoring in Piano Accompanying & Chamber Music. Elective for DMA students in the Piano Accompanying & Chamber Music degree. Open to other keyboard majors with permission of the instructor. May be repeated for credit. (Fall Spring)

431. Voice Repertoire Masters
6VCC 431 (I-1) Voice Repertoire, Masters Level: A two-semester chronological survey of the most important vocal repertoire for the recital & concert stage from Caccini to the present. VCC 431 encompasses early Italian, English, French and German art song up to circa 1900. VCC 432 continues from circa 1900 on and includes French mélodie and a sampling of modern Italian, Spanish, Scandinavian and Russian songs. In-class performance is emphasized in combination with outside listening & reading. The class addresses the repertoire from the dual perspectives of singer & pianist. Required of master's degree students majoring in performance & literature-voice (two semesters) & in piano accompanying & chamber music (as VCC 402-I or II). Open to other majors by permission of the instructor. The two semesters may be taken out of sequence if necessary. (Fall)

432. Voice Repertoire Masters
6VCC 432 (II-1) Voice Repertoire, Masters Level: A two-semester chronological survey of the most important vocal repertoire for the recital & concert stage from Caccini to the present. VCC 431 encompasses early Italian, English, French and German art song up to circa 1900. VCC 432 continues from circa 1900 on and includes French mélodie and a sampling of modern Italian, Spanish, Scandinavian and Russian songs. In-class performance is emphasized in combination with outside listening & reading. The class addresses the repertoire from the dual perspectives of singer & pianist. Required of master's degree students majoring in performance & literature-voice (two semesters) & in piano accompanying & chamber music (as CHB 402-I or II). Open to other majors by permission of the instructor. The two semesters may be taken out of sequence if necessary. (Spring)

590. Ind Stdy:italian Song/Lieder
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Katrina Korfmacher, PhD (Duke)
  Associate Professor of Environmental Medicine
Vyacheslav Korshunov, PhD (Pyatigorsk State Academy of Pharmacy, Russia)
  Associate Professor of Medicine in the Aab Cardiovascular Research Institute
Richard Libby, PhD (Boston College)
  Associate Professor of Ophthalmology
Tanzy Love, PhD (Iowa State)
  Associate Professor of Biostatistics and Computational Biology
Anne E. Luebke, PhD (Johns Hopkins)
  Associate Professor of Biomedical Engineering
Anna Majewska, PhD (Columbia)
  Associate Professor of Neuroscience
Luis Martínez-Sobrido, PhD (Navarra, Spain)
  Associate Professor of Microbiology and Immunology
Margot Mayer-Pröschel, PhD (Würzburg, Germany)
  Associate Professor of Biomedical Genetics
Scott McIntosh, PhD (Miami)
  Associate Professor of Public Health Sciences
Supriya Mohile, MD (Thomas Jefferson)
  Associate Professor of Medicine
Craig Morrell, PhD (Johns Hopkins)
  Associate Professor of Medicine in the Aab Cardiovascular Research Institute
Joshua Munger, PhD (Chicago)
  Associate Professor of Biochemistry and Biophysics
Shawn Murphy, PhD (Duke)
  Associate Professor of Obstetrics and Gynecology
Catherine Ovitt, PhD (Washington, Saint Louis)
  Associate Professor of Biomedical Genetics
Martin S. Pavelka, PhD (Rochester)
  Associate Professor of Microbiology and Immunology
Diane T. Pickut, PhD (Boston)
  Associate Professor of Neuroscience
George A. Porter, PhD, MD (Maryland, Baltimore)
  Associate Professor of Pediatrics
Douglas Portman, PhD (Pennsylvania)
  Associate Professor of Biomedical Genetics in the Center for Neural Development and Disease
Christoph Pröschel, PhD (Oxford, England)
  Associate Professor of Biomedical Genetics
Xing Qiu, PhD (Rochester)
  Associate Professor of Biostatistics and Computational Biology
Arshad Rahman, PhD (Aligarh Muslim, India)
  Associate Professor of Pediatrics
Matthew Rand, PhD (Vermont)
  Associate Professor of Environmental Medicine
Eileen Redmond, PhD (University College Dublin, Ireland)
  Associate Professor of Surgery
David O. Rich, ScD (Harvard)
  Associate Professor of Public Health Sciences
Lizabeth M. Romanski, PhD (Cornell)
  Associate Professor of Neuroscience
Robert Schor, PhD (Rockefeller)
  Associate Professor of Neuroscience
Scott H. Seidman, PhD (Case Western Reserve)
  Associate Professor of Biomedical Engineering
Christopher Seplaki, PhD (Wisconsin)
  Associate Professor of Public Health Sciences
Toru Takimoto, PhD (Hokkaido, Japan)
  Associate Professor of Microbiology and Immunology
Sally W. Thurston, PhD (Harvard)
  Associate Professor of Biostatistics and Computational Biology
Edwin van Wijngaarden, PhD (North Carolina, Chapel Hill)
  Associate Professor of Public Health Sciences
Peter Veazie, PhD (Minnesota)  
  Assistant Professor of Public Health Sciences

Brian Ward, PhD (Illinois)  
  Associate Professor of Microbiology and Immunology

Terry Wright, PhD (Rochester)  
  Associate Professor of Pediatrics

Tongtong Wu, PhD (California, Los Angeles)  
  Associate Professor of Biostatistics and Computational Biology

Houhui Xia, PhD (California, San Francisco)  
  Paul Stark Professor in Pharmacology and Associate Professor of Pharmacology and Physiology

Lei Xu, PhD (Indiana)  
  Associate Professor of Biomedical Genetics

Felix Yarovinsky, MD (Russian State Medical)  
  Associate Professor of Microbiology and Immunology in the Center for Vaccine Biology and Immunology

Xinpeng Zhang, PhD (Rochester)  
  Associate Professor of Orthopaedics in the Center for Musculoskeletal Research

Michael Zusckik, PhD (Rochester)  
  Associate Professor of Orthopaedics in the Center for Musculoskeletal Research

Joshua Sehgal, PhD (Rochester)  
  Assistant Professor of Biostatistics and Computational Biology

Jennifer Jonason, PhD (Yale)  
  Assistant Professor of Orthopaedics in the Center for Musculoskeletal Research

Todd Jusko, PhD (Washington, Seattle)  
  Assistant Professor in Public Health Sciences

James J. Kobie, PhD (Arizona)  
  Assistant Professor of Medicine

Xin Zhiguo Li, PhD (Cornell)  
  Assistant Professor of Biochemistry and Biophysics

Yu Liu, PhD (Vanderbilt)  
  Assistant Professor in Public Health Sciences

Alanya E. Loiselle, PhD (Rochester)  
  Assistant Professor of Orthopaedics in the Center for Musculoskeletal Research

David MacLean, PhD (McGill, Canada)  
  Assistant Professor of Pharmacology and Physiology

Matthew McCall, PhD (Johns Hopkins)  
  Assistant Professor of Biostatistics and Computational Biology

Andrew McDavid, PhD (Washington)  
  Assistant Professor of Biostatistics and Computational Biology

Jennifer Nayak, MD (SUNY, Buffalo)  
  Assistant Professor of Pediatrics

Mitchell O’Connell, PhD (Sydney, Australia)  
  Assistant Professor of Biochemistry and Biophysics

Alexander Paciorkowski, MD (Connecticut)  
  Assistant Professor of Neurology

Krishnan Padmanabhan, PhD (Carnegie Mellon)  
  Assistant Professor of Neuroscience

Jinjiang Pang, PhD (Peking Union Medical College, China)  
  Assistant Professor of Medicine in the Aab Cardiovascular Research Institute

Martina Poletti, PhD (Boston)  
  Assistant Professor of Neuroscience

Jesse Schallek, PhD (SUNY Upstate Medical)  
  Assistant Professor of Ophthalmology

Ruchira Singh, PhD (Kansas State)  
  Assistant Professor of Ophthalmology

Eric M. Small, PhD (Texas, Austin)  
  Assistant Professor of Medicine in the Aab Cardiovascular Research Institute

Laurie A. Steiner, MD (Mount Sinai School of Medicine)  
  Assistant Professor of Pediatrics

Martha Susiarijo, PhD (Case Western Reserve)  
  Assistant Professor of Environmental Medicine

Juilee Thakar, PhD (Würzburg, Germany)  
  Assistant Professor of Microbiology and Immunology

Andrew P. Wojtovich, PhD (Rochester)  
  Assistant Professor of Anesthesiology and Perioperative Medicine

Chao Xie, BMed (Zunyi Medical College, China)  
  Assistant Professor of Orthopaedics in the Center for Musculoskeletal Research

Tingting Yang, PhD (Johns Hopkins)  
  Assistant Professor of Pharmacology and Physiology

Peng Yao, PhD (Chinese Academy of Sciences, China)  
  Assistant Professor of Medicine in the Aab Cardiovascular Research Institute

Zhengwu Zhang, PhD (Florida State)  
  Assistant Professor of Biostatistics and Computational Biology

Jian Zhu, PhD (Johns Hopkins)  
  Assistant Professor of Microbiology and Immunology
General Information

The School of Medicine and Dentistry is home to graduate programs covering a broad range of disciplines within the biomedical and health sciences leading to MA, MPH, MS, and PhD degrees. Graduate students in the School of Medicine and Dentistry are under the administrative supervision of the senior associate dean for graduate education.

Under present regulations, responsibility for the master’s degree programs rests with the Committee on Graduate Studies of the School of Medicine and Dentistry and the senior associate dean for graduate education. The PhD programs are under the same aegis, but ultimate responsibility for approval of PhD degrees and general regulations rests with the University Council on Graduate Studies and the University dean of graduate studies.

Admission to the PhD program is through 1 of 13 training programs. These programs focus on interdisciplinary training with in-depth investigation of an original problem of fundamental importance to the biomedical and health sciences. Each degree program sets its own curriculum, but many courses are taught by groups of faculty from multiple programs and departments. Flexibility is a priority to ensure that all students obtain the best possible training for pursuing careers in their areas of interest. These training programs enable students to carry out thesis research and training with the School of Medicine and Dentistry faculty, as well as investigators from our River Campus in the departments of biology, biomedical engineering, brain and cognitive sciences, chemistry, and optics.

Admission to master’s degree programs is through 1 of 12 training programs in the basic and health sciences including clinical investigation, epidemiology, health services research and policy, marriage and family therapy, medical humanities, microbiology, immunology and virology, medical statistics, microbiology, neurobiology and anatomy, public health, and technical entrepreneurship and management in biomanufacturing and therapeutic development.

MD/PhD and MD/MS Programs

Students especially interested in a program leading to both the MD and the PhD degrees may apply for the combined degree program. The fields in which the PhD degree is most likely to be obtained in the joint program at present are biochemistry, biology,* biomedical engineering, biophysics, chemistry, genetics, epidemiology, health services research and policy, microbiology and immunology, neurobiology and anatomy, neuroscience, optics, pathology, pharmacology, physiology, statistics, toxicology, and translational biomedical sciences. Areas of the social sciences and business management of particular pertinence to medicine have been developed for an MD/MS degree and are available on an ad hoc basis for MD/PhD studies.

Admission to the combined degree program ordinarily is by joint application to the MD and PhD programs; however, this may be after a year or two of study as either a graduate student or a medical student. The candidates must be acceptable as both a medical and a graduate student before they can be fully matriculated in the combined degree program. The MD/PhD curriculum is unique; the distinctive requirements for each degree are preserved, however, the time required is less than the two degrees if taken in sequence. The MS and MPH degrees can also be combined with the MD by use of the special programs in the areas of health care delivery (master of public health, systems analysis, business administration, etc.).

Detailed information on the School of Medicine and Dentistry doctoral and master’s degree programs, curricula, and research, as well as admissions information, can be found at the Office for Graduate Education and Postdoctoral Affairs website www.urmc.rochester.edu/education/graduate/home/index.cfm.

* In the School of Arts & Sciences; see announcement in this bulletin.
Biochemistry and Biophysics


Biochemistry Degree Programs

The Biochemistry and Molecular Biology (BMB) Program is designed for students interested in obtaining an MS (Plan A and Plan B) and PhD in biochemistry. As such, the program represents a group of faculty that may mentor a student pursuing thesis research toward the biochemistry PhD. The program offers in-depth coursework and diverse research opportunities that focus on understanding the biochemical mechanisms of life’s critical molecular processes. World-class research in our laboratories exposes our students to a variety of the latest methods for sophisticated biochemical analysis, including mass spectrometry, crystallography, microcalorimetry, surface plasmon resonance, microarrays, fluorescence-activated cell sorting, light scattering, and spectroscopic methods (including fluorescence lifetime and energy transfer measurements), as well as modern methods for cell culture, protein purification, genetic analysis, and reconstitution of biochemical complexes and reactions. The flexibility of our training program allows students to train in a number of exciting research areas, and often allows students to develop highly effective interdisciplinary collaborations, resulting in cutting-edge thesis projects. Students are encouraged to choose from the numerous courses and seminars offered through the various departments in the School of Medicine and Dentistry and the Department of Biology in the College. The qualifying examination for the PhD is generally completed by the end of the fifth semester in residence.

Course Requirements

Core Courses (required for all programs of study): IND 408 (Advanced Biochemistry); IND 409 (Cell Biology); IND 410 (Molecular Biology and Genomics); IND 501 (Ethics and Professional Integrity in Research); BCH 412 (Advanced Topics in Biological Macromolecules); BCH 501/502 (Seminars in Biochemistry); BCH 495 or 595 (MS or PhD Research).

Elective Courses (suggested but not limited to): BCH 515 (Critical Thinking in Research Science); BCH 517 (Topics in Cellular, Biochemical and Molecular Sciences); BIO 415 (Molecular Biology of Cell Signaling); BIO 422 (Biology of Aging); BIO 426 (Developmental Biology); BIO 435 (Computational Biology); BPH 509 (Molecular Biophysics); BST 461 (Introduction to Biostatistics); GEN 507 (Advanced Genetics); IND 419 (Introduction to Quantitative Biology); IND 443 (Eukaryotic Gene Regulations); IND 447 (Signal Transduction); MBI 456 (General Virology); MBI 473 (Immunology); PTH 507 (Cancer Biology).

MS Program (Plan A)

A “Plan A” (terminal) MS degree is offered by the biochemistry program, subject to approval by the graduate studies director. No financial resources are provided by the biochemistry MS program for either tuition or stipend costs, so that these obligations must be borne by the candidate alone or in conjunction with funds provided at the discretion of the advisor from the sponsoring advisor’s budget. At least one year (two semesters) of full-time enrollment or two years (four semesters) of part-time enrollment is required (the equivalent of two years of full-time study is usual). In the first year, coursework requirements are fulfilled (30 hours) with initiation of the research project. The second year is spent in research activity leading to submission of the MS thesis.

MS Program (Plan B) and Qualifying Examination

Upon completion of the required coursework, a research proposal is written that serves as the basis for determining the potential of the student for independent thought and his or her comprehension of the general field and perspective for exploiting a relevant problem in a scientifically sound manner. The student completes the requirements for a Plan B master’s degree upon successfully passing this qualifying examination.

PhD Program

Students admitted to the PhD program choose a laboratory and advisor at the end of their first year of study after completing at least three laboratory rotations. PhD students are required to work as Teaching Assistants for one semester and pass the qualifying examination in their third year of study. Students are also required to make at least six research presentations in approved seminar courses or seminar series during their course of study.

BIOCHEMISTRY (BCH)

412. Advanced Topics in Biomacromolecules
Prerequisite: IND 408 or an equivalent Biochemistry course

An advanced biochemistry lecture course intended for senior undergraduate and graduate students. Topics include DNA structure, RNA structure and catalysis, nucleic acid–protein interactions, x-ray crystallography, NMR spectroscopy, protein folding, molecular chaperones, membrane proteins, post-translational modifications of proteins, ATPases, G protein and function, protein-protein interactions, proteases and cascade reaction pathways. (Spring)

491. Master’s Readings

* Primary appointment in another department
493. Master’s Essay
495. Master’s Research

501. Biochemistry Seminar
Seminar courses are given each semester. Continuous registration is required of all students in biochemistry. Seminars are given once a week by different graduate students throughout the semester, in which students describe their thesis research to fellow students and faculty. One hour per week. (Fall)

502. Biochemistry Seminar
Seminar courses are given each semester. Continuous registration is required of all students in biochemistry. Seminars are given once a week by different graduate students throughout the semester, in which students describe their thesis research to fellow students and faculty. One hour per week. (Spring)

515. Critical Thinking in Research Science
Prerequisite: Permission of Instructor
Students present a history of experimental work leading to their research project. This includes a selection of published and unpublished work from their advisor’s lab and other labs in the same field, providing a rationale for the project. Students conclude with a report of their published and preliminary data. Focus will be on interpreting experimental data and engaging student interactions. (Fall Spring)

517. Cellular and Molecular Sciences
Students attend presentations in the Department of Biochemistry and Biophysics Seminar Series. Instructors and students select speakers and read 1-3 publications (suggested by the speaker) in depth. Students present these papers to the class, instructors and the speaker’s faculty host in a journal club setting prior to the speaker’s arrival. Finally, students attend a post-seminar class with the selected speaker.

997. Doctoral Dissertation
999. Doctoral Dissertation

Biophysics Degree Programs
The PhD program in biophysics teaches students how to employ the methods of mathematics, physics, chemistry, and biology in biomedical research. It emphasizes the use of physics, physical chemistry, and computational approaches to understand how living organisms work at a molecular level. This interdisciplinary program is administered by faculty from a variety of departments: biochemistry and biophysics, pharmacology and physiology, and radiology in the School of Medicine and Dentistry; biomedical engineering, chemistry, and the Institute of Optics in the College. Collectively, this group of faculty and their students form the Biophysics, Structural, and Computational Biology (BSCB) program.

BSCB has a variety of state-of-the-art facilities available for students. They include 600, 500, and 400 MHz NMR spectrometers, a macromolecular X-ray crystallography laboratory, 2 EPR spectrometers, computer workstations for molecular graphics and structure calculations, a confocal microscope, and confocal fluorescence imaging system. In addition, laboratories are well equipped for modern biochemistry and molecular biology.

Students enter the program with a wide range of backgrounds. The most common backgrounds are physics or chemistry, but engineering, biology, biochemistry, and mathematics majors also enter the program. The program specializes in bringing students from the physical/chemical sciences to a high level of proficiency in the biological sciences and teaching the more biologically trained students how to apply the tools of biophysics in biomedical research. All students admitted receive full tuition scholarship, paid health insurance, and an annual stipend.

The curriculum consists of core course requirements, general seminar and distribution requirements, elective courses, and laboratory rotations. The goal is to provide a balanced set of courses that brings the candidate to the forefront of current knowledge in the selected area while providing general familiarity in related fields. All first-year students are required to complete three laboratory rotations during the first year, one of which must be with a member of the Biophysics, Structural and Computational Biology program faculty. Participation in seminar programs is an important part of the graduate education experience and remains a component of the experience throughout residence.

Formal graduate course requirements generally are fulfilled within the first two years in residence. PhD thesis advisors are generally selected by the end of the second semester in residence and research on the thesis problem generally begins at the end of the first year. A first-year written and oral examination and a second-year written and oral examination comprise the qualifying examination for the PhD and are generally completed by the end of the fifth semester in residence.

Course Requirements
Core Courses (required for all programs of study): IND 408 (Advanced Biochemistry); IND 409 (Cell Biology); IND 410 (Molecular Biology and Genomics); IND 501 (Ethics and Professional Integrity in Research); BPH 411 (Methods in Structural Biology); BPH 509 (Molecular Biophysics); BPH 567 (Writing Proposals in BPH); BPH 571/572 (Biophysics Seminar); BPH 595 (PhD Research).

Elective Courses (suggested but not limited to): BIO 402 (Molecular Biology); BCH 412 (Advanced Topics in Biological Macromolecules); BCH 515 (Critical Thinking in Research Science); BCH 517 (Cellular and Molecular Sciences); BME 442 (Microbiomechanics); CHM 414 (Biological Inorganic Chemistry); CHM 416 (X-ray Crystallography); CHM 423 (NMR Spectroscopy); CHM 469 (Computational Chemistry); IND 443 (Eukaryotic Gene Regulation); IND 447 (Signal Transduction).

BIOPHYSICS (BPH)

402. Math Methods of Physiology & Medicine
403. Math for Molecular BPH
408. Math Methods of BPH

411. Methods in Structural Biology
An introduction to the theory and practical application of several major techniques used in the structural characterization of biological macromolecules. These methods include: X-ray crystallography, Small Angle X-ray Scattering, Spectroscopic and Calorimetric Techniques, NMR and Comparative Modeling. The goal is to enable non-specialists to become conversant in the language and principles of the field, as well as to understand the strengths and limitations of various techniques.

483. Biosolid Mechanics

491. Master’s Readings

492. Special Topics in BPH

493. Master’s Essay

495. Master’s Research

509. Molecular Biophysics
Prerequisite: Students not in the Biophysics program should consult the course director before registering.

This course will instruct students in theoretical, experimental, and computational methods currently used in the study of macromolecules. Instruction includes statistical mechanics, optical melting experiments, dynamic programming algorithms, molecular dynamics, FRET, protein folding, isothermal titration calorimetry, and surface plasmon resonance. Offered every other year (odd numbered years) (Spring)

567. Writing Proposals in Biophysics
This class is designed to teach students the mechanics of writing an NIH-format research proposal. Weekly assignments focus on writing individual sections of the proposal, with detailed feedback provided on each section. The course concludes with an overview of the proposal review process, and a mock review panel. This course provides students with the necessary background for writing their thesis proposal.

571. Biophysics Seminar
Seminar courses are given each semester. Continuous registration is required of all students in biophysics. Seminars are given once a week by different graduate students throughout the semester, in which students describe their thesis research to fellow students and faculty. One hour per week. (Fall)

572. Biophysics Seminar
Seminar courses are given each semester. Continuous registration is required of all students in biophysics. Seminars are given once a week by different graduate students throughout the semester, in which students describe their thesis research to fellow students and faculty. One hour per week. (Spring)

Biostatistics and Computational Biology

Professors McDermott, Oakes, Peterson, Strawderman (Chair)
Associate Professors Almudevar, Beck, Feng, Johnson, Love, Qiu, Thurston, Wu
Assistant Professors Ertefaie, McCall, McDavid, Zhang

The Department of Biostatistics and Computational Biology offers programs leading to the Doctor of Philosophy, Master of Arts, and Master of Science degrees. The department conducts a program of teaching and research in statistical theory and statistical methodology oriented toward the health sciences. Department faculty have research interests and expertise in virtually all areas of modern theoretical and applied statistics. Faculty are involved in wide-ranging collaborative activity with basic science and clinical departments in the School of Medicine and Dentistry. This environment is ideally suited for training in research in statistical methodology, collaborative research, and consulting.

The curriculum is designed to provide students with a thorough grounding in statistical theory, which provides the necessary foundation for the successful conduct of research in statistical methodology. Included are core courses in probability, stochastic processes, statistical inference, large sample theory, and Bayesian inference. The curriculum also provides students with an appreciation for applied problems in biomedical research and the skills necessary to succeed in collaborative research environments. Core courses focused on applications include Statistical Computing, Categorical Data Analysis, and Design of Clinical Trials. Additional core courses including Linear Models, Generalized Linear Models, Survival Analysis, and Analysis of Longitudinal and Dependent Data provide a mix of theory and application. Courses in High Dimensional Data Analysis, Computational Systems Biology, and Genomic Data Analysis are designed for those interested in a concentration in Bioinformatics and Computational Biology. Several elective courses are also offered. An important goal is to produce graduates with a command of technical skills and the ability and experience to use them appropriately.

Department faculty provide instruction to Medical Center faculty, fellows, postdoctoral trainees, and graduate students from basic science and clinical departments through a sequence of courses in biostatistical methods and clinical trial design (BST 463, Introduction to Biostatistics; 464, Applied Linear Regression; 465, Design of Clinical Trials; 466, Categorical Data Analysis; and 467, Applied Statistics in the Biomedical Sciences). Doctoral students serve as teaching assistants in these courses during the first two years of study. A training grant in Environmental Health Biostatistics (funded by the National Institute of Environmental Health Sciences [NIEHS]) helps support predoctoral and postdoctoral training.
### PhD Degrees

**Program for the Degree of Doctor of Philosophy in Statistics (Traditional)**

The department administers the doctoral program in statistics. The department interprets the term “statistics” very broadly. The program permits specialization in probability, statistical theory and analysis, biostatistics, and interdisciplinary areas of application. Students have opportunities for supervised teaching and supervised consulting experience, requiring approximately 12 to 15 hours of effort per week.

A candidate for admission to the PhD program should have a strong background in mathematics, including advanced calculus or mathematical analysis (similar to MTH 265), a course in linear and/or matrix algebra (similar to MTH 165), and a year of probability and mathematical statistics (similar to STT 201 and STT 203). A course in statistical methods is also recommended; however, promising students may make up deficiencies after matriculation. While some background in biology may be helpful for pursuing certain avenues of research, it is not required for admission to the program.

Doctoral students are expected to attain some competence in each of the following (overlapping) areas: I. statistical inference; II. statistical analysis (theory and methods); III. probability and stochastic processes. In addition, each student is expected to qualify at a more advanced level in two areas, designated major and minor. Minor areas, in addition to those three above, include IV. mathematics; V. epidemiology; VI. biostatistics; and VII. a specific field of application, such as econometrics, psychometrics, computer science, genetics, computational biology, engineering, etc. Students are required to acquire some proficiency in statistical computation, using at least one high-level language and several statistical packages. There is no formal specific language requirement, but students undertaking certain areas of research may find it necessary to undertake appropriate language study.

Students are required to take a minimum of 16 formal courses, including:

1. Basic courses: at least two courses in each of the areas I, II, and III and at least three in areas IV–VII combined.
2. Major area: at least three additional courses (12 credits), ordinarily at the 500 level, in one of the areas I–III (or IV–VII with permission).
3. Minor area: at least two additional courses in another one of the seven areas.

Beginning students should expect to spend all of their first year, most of their second year, and some of their third year taking formal courses. This includes a minimum of six semesters of BST 487, a one-credit seminar course designed to give students extensive practice in searching the statistical literature and preparing and delivering presentations. The balance of time is spent on reading and research. Students entering with advanced training in statistics may transfer credits at the discretion of their advisors and in accordance with University policy. A typical program for an entering student without previous advanced training is as follows:

<table>
<thead>
<tr>
<th>Year 1: Fall</th>
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<tbody>
<tr>
<td>BST 401. Probability Theory (4 credits)</td>
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<tr>
<td>BST 411. Statistical Inference (4 credits)</td>
</tr>
<tr>
<td>BST 430. Introduction to Statistical Computing (4 credits)</td>
</tr>
<tr>
<td>BST 487. Seminar in Statistical Literature (1 credit)</td>
</tr>
<tr>
<td>BST 590. Supervised Teaching (2 credits)</td>
</tr>
<tr>
<td>IND 501. Ethics and Professional Integrity in Research (1 credit)</td>
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<tr>
<th>Year 1: Spring</th>
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<tbody>
<tr>
<td>BST 413. Bayesian Inference (4 credits)</td>
</tr>
<tr>
<td>BST 426. Linear Models (4 credits)</td>
</tr>
<tr>
<td>BST 466. Categorical Data Analysis (4 credits)</td>
</tr>
<tr>
<td>BST 487. Seminar in Statistical Literature (1 credit)</td>
</tr>
<tr>
<td>BST 590. Supervised Teaching (3 credits)</td>
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</tbody>
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<table>
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<tr>
<th>Year 2: Fall</th>
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</thead>
<tbody>
<tr>
<td>BST 402. Stochastic Processes (4 credits)</td>
</tr>
<tr>
<td>BST 479. Generalized Linear Models (4 credits)</td>
</tr>
<tr>
<td>BST 487. Seminar in Statistical Literature (1 credit)</td>
</tr>
<tr>
<td>BST 590. Supervised Teaching (3 credits)</td>
</tr>
<tr>
<td>Elective (4 credits)</td>
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<tr>
<th>Year 2: Spring</th>
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</thead>
<tbody>
<tr>
<td>BST 412. Large Sample Theory (4 credits)</td>
</tr>
<tr>
<td>BST 487. Seminar in Statistical Literature (1 credit)</td>
</tr>
<tr>
<td>BST 513. Analysis of Longitudinal and Dependent Data (4 credits)</td>
</tr>
<tr>
<td>BST 591. Reading Course at the PhD Level (3 credits)</td>
</tr>
<tr>
<td>Elective (4 credits)</td>
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<th>Year 3+</th>
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</thead>
<tbody>
<tr>
<td>Mostly reading and research, with some 400-level and 500-level courses</td>
</tr>
</tbody>
</table>

### Notes

1. BST 487, Seminar in Statistical Literature (1 credit), is offered every semester. Topics covered vary. PhD students are required to register for at least six semesters.
2. All PhD students are required to have at least four credits of supervised teaching and/or supervised consulting (BST 590, 592).
3. All students in the doctoral program are required to take IND 501, Ethics and Professional Integrity in Research (1 credit), in their first semester in the program.
4. Usually in year two, students begin exploring potential research topics by taking reading courses with faculty (BST 591). The structure, content, and number of credit hours for these courses are flexible and determined by mutual agreement between the students and faculty member.
5. Advanced topics courses in statistical inference, data analysis, and biostatistics (BST 511, 512, 550, or 570), for varying numbers of credits, are offered depending on interests of students and instructors. Recent examples include
Students also have the option of taking relevant courses that are offered through other doctoral programs at the University, such as Mathematics (e.g., MTH 471–Real Analysis), Epidemiology (e.g., PM 416–Epidemiologic Methods), and Health Services Research (e.g., PM 472–Measurement and Evaluation of Research Instruments).

These requirements are to be interpreted as guidelines, rather than as regulations. A balanced program is worked out with the student’s advisor and the graduate advisor. The examination requirement consists of:

1. Written examination in two parts. The basic part covers basic material in areas I–III, based on undergraduate preparation and some of the first-year graduate courses. It is taken after one year of study. The advanced part covers advanced material from two to three core courses in each of areas I–III taken during the first two years of graduate study. This part is usually taken after two years of study.

2. Qualifying examination (oral) on the general area of proposed research and other topics as necessary.

3. Final examination on the completed dissertation.

The dissertation will consist of substantial scholarly contribution, worthy of publication, in one of the areas I–III or in any other area approved by the faculty committee.

Program for the Degree of Doctor of Philosophy in Statistics with Concentration in Bioinformatics and Computational Biology

The Bioinformatics and Computational Biology (BCB) concentration is designed to educate the next generation of biostatisticians with the knowledge required to address critical scientific and public health questions and, in particular, equip them with the skills necessary to both develop and use quantitative and computational methodologies and tools to manage, analyze, and integrate massive amounts of complex biomedical data. Students learn core statistical methods and obtain training in data analysis methodologies and computational skills and techniques necessary for handling big data in the biomedical and public health sciences. In addition to this training in core methods, the program also places great emphasis on cross-training to prepare students to work as part of interdisciplinary teams that require expertise in statistical data science: (1) training students with quantitative/computational science backgrounds to enhance their understanding of biological questions and biological interpretation; and (2) training students with biomedical science backgrounds to proficiently use bioinformatics and computational methods and tools to address scientific questions.

Entering PhD students need undergraduate preparation in mathematics, including advanced calculus or mathematical analysis (similar to MTH 165), a course in linear and/or matrix algebra (similar to MTH 165), and a year of probability and statistics (similar to STT 201 and STT 203). Basic courses in computer science and/or biology are also required. A course in statistical methods is also recommended; however, promising students may make up deficiencies after matriculation.

Formal course and examination requirements for students in the BCB concentration are essentially the same as those for students in the traditional program, with the main differences being in the courses taken in areas IV-VII (with a heavier focus on courses related to bioinformatics and computational biology) and in the material covered on the written examination (advanced part).

Beginning students should expect to spend all of their first year, most of their second year, and some of their third year taking formal courses. The balance of time is spent on reading and research. Students entering with advanced training in statistics, bioinformatics, or computational biology may transfer credits at the discretion of their advisors and in accordance with University policy. A typical program for an entering student without previous training is as follows:

**Year 1: Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BST 401</td>
<td>Probability Theory</td>
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<tr>
<td>BST 411</td>
<td>Statistical Inference</td>
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<tr>
<td>BST 430</td>
<td>Introduction to Statistical Computing</td>
<td>4</td>
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<tr>
<td>BST 487</td>
<td>Seminar in Statistical Literature</td>
<td>1</td>
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<tr>
<td>BST 590</td>
<td>Supervised Teaching</td>
<td>2</td>
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<tr>
<td>IND 501</td>
<td>Ethics and Professional Integrity in Research</td>
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**Year 1: Spring**

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>BST 413</td>
<td>Bayesian Inference</td>
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<tr>
<td>BST 426</td>
<td>Linear Models</td>
<td>4</td>
</tr>
<tr>
<td>BST 487</td>
<td>Seminar in Statistical Literature</td>
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<tr>
<td>BST 496</td>
<td>Wet/Dry Lab Rotation</td>
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<tr>
<td>BST 590</td>
<td>Supervised Teaching</td>
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**Year 2: Fall**

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<tr>
<th>Course Code</th>
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<tr>
<td>BST 402</td>
<td>Stochastic Processes</td>
<td>4</td>
</tr>
<tr>
<td>BST 432</td>
<td>High-Dimensional Data Analysis</td>
<td>4</td>
</tr>
<tr>
<td>BST 479</td>
<td>Generalized Linear Models</td>
<td>4</td>
</tr>
<tr>
<td>BST 487</td>
<td>Seminar in Statistical Literature</td>
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<td>BST 590</td>
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**Year 2: Spring**

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<tr>
<td>BST 412</td>
<td>Large Sample Theory</td>
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<tr>
<td>BST 434</td>
<td>Genomic Data Analysis</td>
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<tr>
<td>BST 487</td>
<td>Seminar in Statistical Literature</td>
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</tr>
<tr>
<td>BST 591</td>
<td>Reading Course at the PhD Level</td>
<td>3</td>
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**Year 3+**

Mostly reading and research, with some 400-level and 500-level courses.
Notes
1. All PhD students are required to have at least four credits of supervised teaching and/or supervised consulting (BST 90, 92).
2. All students in the doctoral program are required to take IND 501, Ethics and Professional Integrity in Research (1 credit), in their first semester in the program.
3. Usually in year two, students begin exploring potential research topics by taking reading courses with faculty (BST 591). The structure, content, and number of credit hours for these courses are flexible and determined by mutual agreement between the student and faculty member.
4. As with the traditional PhD program, advanced topics courses in statistical inference, data analysis, and biostatistics (BST 511, 512, 550, or 570), for varying numbers of credits, are offered depending on interests of students and instructors.

The examination requirements for students in the BCB concentration are the same as for students in the traditional PhD program.

Considerations for Students in the MD/PhD Program
Students admitted to the MD/PhD program follow essentially the same course of study as students in the PhD program, except that coursework in statistics begins during the fall of the third year in the program. During the first year, students spend three months (June–August) with a mentor to begin the process of orientation toward research in statistical methodology. This may be implemented either as an informal (noncredit) reading course or as involvement in an applied project that may motivate a methodological research problem. This is repeated during the second year of the program (March–August) just prior to the start of coursework. The main goals of these interactions are to provide the student some insight regarding the process of research in statistical methodology and to facilitate the process of choosing a research advisor.

Master’s Degrees
Program for the Master of Arts Degree in Statistics
The requirements for entry into the MA program are the same as those for entry into the traditional PhD program. The MA degree requires satisfactory completion of at least 32 credits and a final examination (the basic part of examination requirement (1) above or an oral examination); no thesis is required. Of the 32 credits, at least 24 must be in departmental courses primarily at the 400 level or above. All three areas (I–III above) must be represented. Appropriate substitutions may be made as long as the spirit (distribution and level) of the requirements is met. A balanced program is worked out with the student’s advisor. A typical program for the MA is the same as that in the first three semesters of the PhD program.

Students in the PhD program receive an MA degree upon satisfactory completion of the requirements for this degree (typically during the second year of graduate study).

Program for the Master of Science Degree in Medical Statistics
The MS program in medical statistics is primarily intended for students who wish to follow careers in health-related professions such as those in the pharmaceutical industry and biomedical or clinical research organizations. For entry into the program, three semesters of calculus, a course in linear and/or matrix algebra (similar to MTH 165), a course in probability (similar to STT 201), a course in mathematical statistics (similar to STT 203), and a course in applied statistics (similar to STT 212) are required.

The MS program in medical statistics consists of one core year (two semesters) of coursework as well as an internship/applied project (BST 493), which is normally taken in the summer after the core program. There are no thesis or language requirements. The degree requires 32 credit hours consisting of the courses listed below; substitutions may be made with approval of the faculty program advisor.

A comprehensive oral examination to determine the student’s qualifications for the MS degree will be administered upon completion of coursework and the internship/applied project.

A typical program for an entering student without previous advanced training is as follows:

<table>
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<tr>
<th>Fall</th>
<th>Spring</th>
<th>Summer</th>
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<tbody>
<tr>
<td>BST 411. Statistical Inference (4 credits)</td>
<td>BST 413. Bayesian Inference or Elective (4 credits)</td>
<td>BST 493. Internship/Applied Project (8 credits)</td>
</tr>
<tr>
<td>BST 430. Introduction to Statistical Computing (4 credits)</td>
<td>BST 465. Design of Clinical Trials (4 credits)</td>
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<tr>
<td>BST 464. Applied Linear Regression (4 credits)</td>
<td>BST 466. Categorical Data Analysis (4 credits)</td>
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BIOSTATISTICS (BST)

401. Probability Theory
Prerequisite: MTH 265 or equivalent (or permission).
Probability spaces; random variables; independence; distributions; expectation; characteristic functions and inversion theorems; convergence; laws of large numbers; central limit theorem. (Fall)

402. Stochastic Processes
Prerequisite: BST 401.
Markov chains; birth-death processes; random walks; renewal theory; Poisson processes; Brownian motion; branching processes; martingales; with applications. (Fall)

411. Statistical Inference
Prerequisite: STT 203 or equivalent.
Probability distributions, transformations and sampling distributions; statistical models; estimation, hypothesis testing, and confidence intervals for parametric models; introduction to large-sample methods. (Fall)
412. Large Sample Theory
Prerequisites: BST 401 and BST 411.

Weak convergence; asymptotic linearity; local analysis; large sample estimation, maximum likelihood estimation and M-estimation; Wald, likelihood ratio, and score tests; confidence regions; nuisance parameters; efficiency; multinomial chi-square tests. (Spring)

413. Bayesian Inference
Prerequisite: BST 411.

Posterior distributions for single and multiple parameter models under conjugacy; hierarchical models; noninformative and informative prior distributions; modern computational techniques, including Markov chain Monte Carlo; model checking; posterior predictive checks; sensitivity analysis. (Spring)

416. Applied Statistics II
Prerequisite: STT 211 or STT 212 or BST 463 or equivalent.

One- and two-way analysis of variance; simple and multiple regression; analysis of covariance; analysis of residuals, use of transformations; topics from contingency table analysis and nonparametric statistics. Emphasis on real examples from the biomedical and social sciences, with extensive use of statistical software. (Spring)

421. Sampling Techniques
Prerequisite: STT 203 or STT 213. Parent course is STT 221W.

Simple random, stratified, systematic, and cluster sampling; estimation of the means, proportions, variance, and ratios of a finite population. Ratio and regression methods of estimation and the use of auxiliary information. The nonresponse problem. (Fall)

426. Linear Models
Prerequisites: STT 203 and MTH 235.

Theory of least-squares; point estimation in the general linear model; projection operators, estimable functions and generalized inverses; tests of general linear hypotheses; power; confidence intervals and ellipsoids; simultaneous inference; linear and polynomial regression; analysis of variance and analysis of covariance models; fixed, random, and mixed effects; correlation; prediction. (Spring)

430. Intro Statistical Computing

431. Intro to Computational Bio
Prerequisites: Differential Equations and BST 401.

Topics include: Basics of statistical learning; Nucleic acid sequence modeling; Protein sequence modeling; Molecule structure and visualization; Data exploration by clustering; Phylogenetic trees; Cell pathway; Network dynamics and topology analysis; Modeling molecular events; Biochemical and cell kinetics; Compartamental analysis; Population dynamics; Basics of digital image processing; Image feature extraction and pattern analysis; and image modeling.

432. High Dimensional Data Analysis
Prerequisites: BST 401 and BST 411.

Application of statistical theory to the analysis of high throughput data; introduction to Bioconductor; molecular profiles (mRNA, cDNA, microRNA, proteomics); platforms (Affymetrix and other microarrays, PCR, RNA seq); quality control (quality assessment, batch-effects); exploratory methods (graphical methods, clustering, principal component analysis and other dimension reduction techniques); differential expression and multiple hypothesis testing; classification (feature selection, multivariate methods, machine learning, cross-validation).

433. Computational Systems Biology
Prerequisites: Calculus, Differential Equations, BST 401, and BST 411.

This course intends to introduce students with basic concepts of a "system" and system theory with applications to modeling biological systems and processes. In particular, we train students to have a systems thinking in biomedical research with a solid systems science approach. The contents include 1) Introduction to systems concepts and systems theory. 2) Mathematical representations of systems. 3) Linear ODE systems. 4) Nonlinear ODE systems. 5) Network motifs. 6) Network robustness. 7) Modeling of biochemical systems. 8) Gene regulatory network systems. 9) Multi-scale biological systems. 10) Systems biology experimental design. 11) Identification of biological systems using experimental data.

441. Applied Multivariate Analysis
Prerequisite: BST 426 or BST 476. Parent course is STT 241.

Methodology and applications of multivariate analysis; Hotelling’s T2; multivariate regression and analysis of variance; classification and discrimination; principal components, clustering, and multidimensional scaling; use of statistical software. (Spring)

463. Introduction to Biostatistics
Prerequisite: Permission of instructor required for undergraduates.

Introduction to statistical techniques with emphasis on applications in the health sciences. Summarizing and displaying data; introduction to probability; Bayes' theorem and its application in diagnostic testing; binomial, Poisson, and normal distributions; sampling distributions; estimation, confidence intervals, and hypothesis testing involving means and proportions; simple correlation and regression; contingency tables; use of statistical software. (Fall)

464. Applied Linear Regression
Prerequisite: BST 463 or equivalent. Permission of instructor required for undergraduates.

One- and two-way analysis of variance; multiple comparisons involving means; fixed and random effects; simple and multiple linear regression; analysis of covariance; interactions; correlation and partial correlation; multicollinearity; model selection; model checking. (Fall)
465. Design of Clinical Trials  
Prerequisite: BST 463 or equivalent. Permission of instructor required for undergraduates.

Introduction to the principles of clinical trials; clinical trial protocols; overview of the drug development process; hypotheses/objectives; specification of response variables; defining the study population; randomization; blinding; ethical issues; factorial designs; crossover designs; equivalence trials; trial monitoring and interim analyses; sample size and power; issues in data analysis and reporting; evaluating clinical trial reports. (Spring)

466. Categorical Data Analysis  
Prerequisite: BST 464 or equivalent. Permission of instructor required for undergraduates.

Measures of association for categorical outcomes; contingency table analysis; regression analysis for binary, polytomous, count and time-to-event responses; emphasis on general ideas and applications of models and methods using statistical software such as SAS; review of necessary theory underlying likelihood and nonparametric inference as it pertains to the development of relevant models and test statistics. (Spring)

467. Applied Statistics in the Biomedical Sciences  
Prerequisites: Registration and completion of IND 418 Biostatistics Bootcamp required for all registrants.

Experimental design, statistical inference, hypothesis testing, linear and non-linear regression analysis and model diagnosis, analysis of time-to-event data, sample size and power calculation, and genomic data analysis (Spring)

470. Internship/Applied Project  

479. Generalized Linear Models  
Prerequisites: BST 411 and BST 426.

Generalized linear models; computational techniques for model fitting; logistic and conditional logistic regression; Poisson and negative binomial regression; log-linear models; models for nominal and ordinal categorical data; quasi-likelihood functions; model checking; nonlinear regression models. (Fall)

487. Seminar in Statistical Literature  

Provides an introduction to the process of searching the statistical literature, opportunities to acquire knowledge of a focused area of statistical research, experience in organizing, preparing, and delivering oral presentations, and an introduction to the research interests of members of the faculty. (Fall Spring)

491. Masters Reading  

Special work, arranged individually.

493. Internship/Applied Project  

As required for completion of the M.S. degree in medical statistics, the student works on a medical research project under the guidance of department faculty or under supervision in an industrial setting. The student should have contact with medical investigators as well as statisticians. The work should be coherently summarized in a written document. Oral presentation of the work is required. (Fall Spring Summer)

494. Statistical Computing  

495. Masters Research  
Research at the Master’s level.

496. Wet/Dry Lab Rotation  

Students choose a bioinformatics experimental or computational lab for rotations.

497. Seminar in Stat Lit  

511. Topics in Statistical Inference I  
Prerequisite: Varies by topic.

Advanced topics in statistical inference and/or decision theory. (Fall)

512. Topics in Statistical Inference II  
Prerequisite: Varies by topic.

Advanced topics in statistical inference and/or decision theory. (Spring)

513. Analysis of Longitudinal and Dependent Data  
Prerequisites: BST 401 and BST 411 and BST 426.

Modern approaches to the analysis of longitudinal and dependent data; random and mixed effects models; marginal models; generalized estimating equations; models for continuous and discrete outcomes. (Spring)

514. Survival Analysis  
Prerequisites: BST 401, BST 411, and BST 412.

Parametric, nonparametric, and semiparametric methods for the analysis of survival data. Right censoring; Kaplan-Meier curves; log-rank and weighted log-rank tests; survival distributions; accelerated life and proportional hazards regression models; time-dependent covariates; partial likelihood; models for competing risks and multiple events. (Fall)

515. Internship  

520. Intro to Bioinformatics  
Prerequisites: BST 411 and BST 464 or equivalent.

Basic concepts of modern molecular biology; bioinformatics technologies; sequence analysis of nucleic acids and proteins (methods of sequence alignment and associated search algorithms); prediction of structure and functions; protein folding and RNA secondary structure; statistical methods for microarray gene expression data analysis: (1) univariate methods for selecting differentially expressed genes (SAM, step-down and step-up resampling methods, empirical Bayes method) and (2)
multivariate methods for identifying subsets of differentially expressed genes and pathway recognition (distance-based and error-based approaches, successive selection of subsets of genes, testing significance in multivariate settings); selection bias in multivariate analysis and cross-validation of classification rules; Support Vector Machines in the analysis of microarrays; unsupervised learning with microarray data; identification of gene regulatory networks from gene perturbation experiments. (Spring)

525. Intro to Health Informatics
Prerequisites: Permission of instructor required. Health sciences (medical, nursing, public health, etc.) background or technical (computer science, information science, statistics, etc.) background.
Introduction to health informatics; clinical data and biomedical knowledge; electronic medical records and integrated health care information systems; standards for health information technology; natural language and text processing/information retrieval; human factors in health informatics; translational informatics and decision support systems; public health informatics, telemedicine, and patient monitoring; evaluation of health care information systems; consumers, web, and health education.

531. Nonparametric Inference
Prerequisites: BST 411, BST 412, and BST 426.
Nonparametric estimation and inference for one-sample location and paired data, two-sample location and/or dispersion, one- and two-way layouts with and without order restrictions, tests of independence, and regression; exact and large-sample results for some commonly used procedures, including the sign test and the sample median, the Mann-Whitney-Wilcoxon test and the Hodges-Lehmann location measure, and some generalizations to more complex data structures; density estimation; nonparametric regression; generalized additive models (GAM); cross-validation; bandwidth selection; exact and asymptotic bias, variance, and mean squared error (MSE).

541. Multivariate Analysis
Prerequisites: BST 411 and BST 426.
Multivariate normal and Wishart distributions and associated distributions; estimation; invariance reduction; Hotelling’s T2; multivariate general linear model; simultaneous confidence bounds; step down procedures; optimality properties; classification; discrimination; principal components.

550. Topics in Data Analysis
Prerequisite: Permission of instructor required.
Advanced statistical methods for data analysis.

570. Topics in Biostatistics
Prerequisite: Permission of instructor required.
Advanced biostatistical techniques.
cutting-edge science in their field and to interact with experts in their field of study. In addition, there is a wide and vibrant spectrum of relevant internal and external seminars throughout the School of Medicine and the basic science departments of the College.

Graduate student research projects are supported and monitored by the respective mentor and a graduate committee that consists of four faculty members. Typically after the second year of the program, students have to pass a midterm examination that qualifies the candidate for pursuing a PhD in genetics.

### 503. Genetics Seminar

Genetics Seminar held each semester and continuous registration is required of all GEN students and any student whose advisor has a primary appointment in the Department of Biomedical Genetics. Seminars are held every Thursday at 1:30 in KMRB 2-9654 and a minimum of 60% attendance is required. (Fall)

### 504. Genetics Seminar

Genetics Seminar held each semester and continuous registration is required of all GEN students and any student whose advisor has a primary appointment in the Department of Biomedical Genetics. Seminars are held every Thursday at 1:30 in KMRB 2-9654 and a minimum of 60% attendance is required. (Spring)

### 506. Principles in Stem Cell Biology

This course is designed to cover basic principles in stem cell science, the role of stem cell dysfunction in developmental disease, potential therapeutic applications of stem cells, principles of embryonic stem cell and iPSC research and managing the transition from the laboratory to the clinic. The course is structured by combining lectures and group discussions. Discussions are on research papers chosen by the lecturer to complement the material in the lecture, and discussion of these papers follows the formal lecture. Students are also required to submit a research proposal. The proposal may be on any topic in stem cell biology and undergoes three submissions, after each of which students receive one-on-one feedback from the instructors. (Alternate years.) (Fall)

### 507. Advanced Genetics

This course offers in-depth discussions of theoretical concepts and experimental strategies in genetics and genomics. Lectures will cover genetically tractable model organisms, including yeast, Drosophila, Caenorhabditis elegans (a nematode), mouse, and human and their analyses from genome to genome and systems level. Examples of the particular questions that can be addressed with advantage in each genetic model will be presented and the special genetic approaches feasible in these respective systems will be emphasized. The course builds upon a strong prior background in Mendelian and molecular genetics. Topics covered include the genetic basis of pattern formation, cell fate determination, control of cell function, structure-function relationships in macromolecules, and searching for genes important in human health. Additional
topics incorporated recently into the course include genome structure & evolution, small RNAs & mobile genetic elements, epigenetics and genomics, proteomics, and other studies at the whole genome level. (Fall)

508. Genomics and Systems Biology
This is a graduate level course aimed at providing students with the up-to-date scientific information and background knowledge behind the biomedical research into the molecular mechanisms of developmental processes and of disease pathogenesis. The lectures are in modular format with student reading/presentations in each module. Six modules are currently included, each by an instructor(s) most familiar with the topics. The modules include genomic and proteomic approaches to developmental/disease pathways; hematopoiesis and stem cell diseases; CNS development and systems biology; cardiovascular development and diseases; chromatin and gene regulation; and cancer genomics and biology. This course is open to all graduate students in biology and biomedical sciences and is highly recommended for the students in the Genetics, Genomics and Development cluster. In addition to class participation and presentation, students write a final review paper on a topic related to the course discussions. (Spring)

Interdepartmental Courses
Described below are interdepartmental courses for intercollege programs and other purposes. These offerings draw widely on the special qualifications of the faculty in the area independent of faculty departmental affiliations. They should be considered in conjunction with the courses, especially advanced courses, and in the closely allied subjects offered by the individual departments. The courses numbered in the 400 series are taught at a level suitable for beginning graduate students and advanced undergraduates.

408. Advanced Biochemistry
Prerequisites: One semester introductory course in biochemistry, or equivalent
Designed to provide graduate students and advanced undergraduates with an understanding of biochemical and biophysical approaches currently being used to study broad areas of biomedical research and to expose students to major unsolved problems in biochemistry and biophysics. In addition to 80 minute lectures, weekly workshops allow discussion of papers from the current literature and problem sets. (Fall)

409. Cell Biology
IND 409 is a graduate-level survey course in Cell Biology. Some previous exposure to Cell Biology is a prerequisite. As an advanced-level course, our lectures will focus on original experiments, critical thinking, and reading of the primary literature, rather than on rote memorization of facts and details. For those students who have had little or no previous exposure to this material, we suggest that you take an undergraduate-level Cell Biology class (BIO 210) before enrolling in IND 409.

410. Molecular Biology and Genomics
Prerequisites: Student need to have already taken undergraduate level Biochemistry and/or Molecular Biology courses.
This course is designed primarily for graduate students. Hour-long lectures (including 5 one-hour workshops) cover modern topics of interest, including DNA replication, regulation of RNA transcription in eukaryotes, RNA processing, RNA folding, protein translation, and posttranslational modifications. Emphasis is placed on both biochemical and genetic approaches to the study of these problems. Additional topics include genomics as an approach to regulation and yeast/mammalian genetic techniques of analysis. (Spring)

412. Grad Exp in Science Edu

414. Scientific Writing Principles and Practice
Prerequisite: Minimum of 6 enrolled students required for course to be offered.
Scientific Writing: Principles and Practice, is a course for graduate students at all levels, taught by a PhD in English who has extensive experience with scientific writing. All students will work
on a single document throughout the semester: a grant proposal, research article, or a portion of a thesis. Students will turn in a series of writing assignments, receive detailed critiques, and complete the document by the end of the course. Classes will include didactics on grant and article writing, and interactive discussion of writing samples that demonstrate common writing problems. Discussions will also include group reviews of student documents in progress.

415. Postbac Research Edu Program

417. Workshop in Scientific Communications

Workshop in Scientific Communication focuses on clear and concise scientific writing, submission to and publication in scientific and medical journals, learning about and how to use digital resources and bibliography software, building skills to give effective oral/platform presentations and create visually informative posters, and a brief introduction into writing a specific aims page for a grant or thesis proposal. This is a skills-based workshop aimed at improving scientific communication.

418. Biostatistics Boot Camp

Biostatistics Boot Camp is a workshop that provides a foundation and/or refresher for basic statistical concepts for students who will enroll BST 467, Applied Statistics in the Biomedical Sciences, in the spring semester. The primary objectives of this workshop are to provide a basic foundation on key statistical concepts, prepare students for higher-level ideas that will be introduced in BST 467, provide instruction on how to use the software package JMP for data analysis and representation and demonstrate for students how these statistical concepts are relevant to their work in the biological sciences. Each session will be conducted in the computer lab.

419. Introduction to Quantitative Biology

Prerequisite: No previous computational experience is required.

Introduction to Quantitative Biology is a graduate-level survey course that introduces concepts for the analysis of high dimensional biological data.

420. Mastering Scientific Information

This course will teach students about the process of scientific discovery through the lens of the scientific literature, as well as providing skills-focused education to help students effectively search for information and evaluate the quality of that information. The course will also provide students with a brief introduction to a number of tools for managing information as they develop their individual research projects, to support writing of qualifying exam proposals, fellowship applications, manuscripts for publication, and dissertation documents. Further support and education are always available through topic-specific classes offered through Miner Library and one-on-one consultations with students’ Personal Librarians, whom they will meet for the first time during MSI. (Fall)

426. Sci Commun for Div Audiences

Course description: Science Communication for Diverse Audiences offers a hands-on based approach to improve science communication skills. Students will have the opportunity to work in small groups to learn basic presentation skills, distill their scientific message for a multitude of audiences, and become more comfortable presenting in front of groups. We will focus on improving communication with both scientific and non-scientific audiences. This course integrates some of the newest training techniques in the field including improvisation and storytelling, which serve to help scientists better connect to audiences in the moment. The course will also offer brief sections on writing for non-scientific audiences. Participants should come ready to step outside of their comfort zone and dive into a variety of different training techniques from week to week.

436. Ctsi Seminar Series

This student-led “critical thinking in research” course will provide Translational Biomedical Science (TBS) PhD students with a forum for presenting and discussing their planned and ongoing research projects in depth with student peers - including the underlying basis for their studies, experimental design, data interpretation, future studies, and challenges encountered in executing their studies and crossing discipline boundaries. The course will be facilitated by program faculty to provide students with a self-directed learning environment and to encourage participation in a lower-stakes setting. The students will meet 7 times each semester, for 90 min. First and Second year students will give informal work-in-progress presentations to build confidence and develop critical thinking skills; advanced students will give research seminar presentations. Course is open to TBS-IMP PhD students and others by permission of the instructor.

438. Pracical Skills in Grant Writing

This course focuses on fellowship (F30, F31 or F32) or career development (K01, K08, K23 or K99) grants in biomedical & behavioral sciences. Topics include: Funding Opportunity Announcements; Grant sections common to most funding agencies (Specific Aims, Significance, Innovation, Research Strategy, Investigators, Environment); Peer Review of NIH grants; Administrative sections; Candidate’s background, career development goals & training activities; mentor/sponsor statements. Scientific Premise, Rigor & Reproducibility and Authentication of Biologics will be covered. Students participate in a mock grant peer review study session; write a real grant, present grant plans to class and peer review another student’s grant. No prerequisites.

439. Leadership & Mgmt Scientists

443. Eukaryotic Gene Regulation

447. Signal Transduction

Cellular signal transduction is one of the most widely studied topics in the biomedical sciences. Cells have multiple mechanisms for sensing the environment and converting the external
signals into intracellular responses that are important for regulation of human physiology. Dysregulation of these processes can result in disease and manipulations of these pathways are the basis for many therapeutics.

### 501. Ethics and Professional Integrity in Research

IND 501 - This course is required of all graduate students in the biomedical sciences in the School of Medicine and Dentistry. The course features 10 sessions consisting of lecture/case study presentations followed by small group discussions that provide information on the various topics that the National Institutes for Health consider essential for the responsible conduct of research. Specific topics include the ethical issues underlying human experimentation and related conflicts of interest, animal experimentation, the mentor-mentee relationship, scientific misconduct and plagiarism, collaborative and team science, and publication/authorship. The course also provides an introduction to approaches for improving rigor and transparency with the goal of enhancing research reproducibility. 1 credit hour. (Fall)

### 503. Ethics & Prof Integ Clin

### 506. Ethics and Professional Integrity in Research for Postdoctoral Trainees

This course is required of all clinical and basic science postdoctoral trainees in the School of Medicine and Dentistry. The course features 10 sessions consisting of lecture/case study presentations followed by small group discussions that provide information on the various topics that the National Institutes for Health consider essential for the responsible conduct of research. Specific topics include the ethical issues underlying human experimentation and related conflicts of interest, animal experimentation, the mentor-mentee relationship, scientific misconduct and plagiarism, collaborative and team science, and publication/authorship. The course also provides an introduction to approaches for improving rigor and transparency with the goal of enhancing research reproducibility. This is a non-credit bearing course that cannot be applied to any degree program in the School. (Fall)

### 511. University of Rochester Best Internship

**Prerequisites:** Before receiving approval to seek an internship experience, the trainee must show engagement in the URBEST program, demonstrate research productivity and produce an internship proposal with the guidance of Dr. Tracey Baas, URBEST Executive Director.

A URBEST (Broadening Experiences in Scientific Training) Internship is a credit bearing career-related work experience of limited duration (< 3 months) in which a URBEST trainee takes on responsible roles outside of the “traditional” university research environment: such as in a nonprofit organization, a government office, or a for-profit business. Internships must include training, supervision and evaluation. This valuable form of professional training provides URBEST graduate students or postdocs with the opportunity to test their career interests in an off-campus setting.

### Marriage and Family Therapy

**Professor McDaniel**

**Associate Professors Gawinski, Pisani, Podgorski (Codirector), Poleshuck, Speice (Codirector), Watson**

**Assistant Professors Rosenberg, Swanger-Gagné**

**Clinical Senior Instructors Chiang, Guifre**

The Department of Psychiatry offers a Master of Science degree and a Post-degree Certificate in marriage and family therapy through the Family Therapy Training Program, Institute for the Family.

The Family Therapy Training Program has a long history of providing family therapy training and continuing education locally, nationally, and internationally. Built on the work of faculty pioneers in the areas of serious mental illness, substance abuse, cultural transition, medical family therapy, and integrated care, postgraduate training has been provided since 1981. The post-degree program trains professionals from multiple disciplines, including medicine, nursing, social work, and psychology.

Coursework provides a broad-based, integrative, biopsychosocial approach to clinical practice. The program is committed to a systemic and relational understanding of human functioning, with an emphasis on strengths and resilience. The goals of the MS degree program in marriage and family therapy are to (1) provide comprehensive training in marriage and family therapy skills as well as collaboration with other interdisciplinary professionals; (2) teach the major systems approaches and theories and how these theories relate to psychopathology and are influenced by life span, gender, sexuality, race, and culture; (3) prepare culturally aware marriage and family therapists able to serve diverse communities; and (4) train students who are skilled to work in traditional mental health settings as well as integrated care and other settings. The program combines rigorous coursework with intensive clinical training.

Courses in the program blend conceptual, clinical, and self-of-the-therapist considerations to prepare family therapists for professional practice. Clinical training is provided in a variety of supervised formats and settings including our onsite Family Therapy Services, integrated health care, and community settings.

Applicants typically have a bachelor’s degree in education, psychology, social work, sociology, or nursing. In order to graduate, students must successfully complete 60 credit hours that include a supervised clinical practicum.

The Marriage and Family Therapy Training Program at the University of Rochester is accredited by the Commission on Accreditation for Marriage and Family Therapy Education (COAMFTE) of the American Association for Marriage and Family Therapy (AAMFT).
492. Medical Family Therapy Intensive
This course is a week-long intensive designed to introduce students to the foundations of Medical Family Therapy through didactic presentations, small group learning and skills development. Presentations are focused on medical family therapy, models of collaboration, and specific illnesses and their effect on families. Additionally, students take part in 12 hours of small group learning, focusing on family of origin experiences with illness and healthcare, as well as case and systems consultation. Students also engage in 3 hours of Skills Workshops that employ simulated family role plays to focus on executive and professional skills development. (Summer)

494. Special Topics

496. Ind Study: Fam Sys Research

497. Collaborative Practice in Marriage and Family Therapy
Prerequisite: PSI 492 Medical Family Therapy Intensive
Join us and share your experiences in implementing integrated care models, collaboration, and medical family therapy, consult with Susan, and other Institute for the Family faculty, and your alumni colleagues about patients, collaboration, and the systems care at your particular site. The process will be learner-centered and goal-oriented, informed by relevant reading and research. (Spring)

498. Med Fam Therapy Intensive
This course is a week-long intensive designed to introduce students to the foundations of Medical Family Therapy through didactic presentations, small group learning and skills development. Presentations are focused on medical family therapy, models of collaboration, and specific illnesses and their effect on families. Additionally, students take part in 12 hours of small group learning, focusing on family of origin experiences with illness and healthcare, as well as case and systems consultation. Students also engage in 3 hours of Skills Workshops that employ simulated family role plays to focus on executive and professional skills development. (Summer)

504. Classic Rdgs: C & A Psychiatry

539. Family Therapy, Theory and Technique
This course provides an overview of the major theories and clinical approaches in Marriage and Family Therapy, and complements the Foundations of Clinical Practice in Family Therapy (PSI 542) and Human Development Across the Family Life Cycle (PSI 544) courses. Students explore primary source materials as well as independently engage with current literature in the MFT field to find recent applications of the major theories. (Fall)

541. Foundations of Clinical Pracice
This course is an introduction to the thoughtful clinical interview and the artful use of the therapeutic system to promote change in individuals, families, and other systems. This course is a preparation for the basic skills and concepts in clinical interviewing and the practice of family therapy. (Fall)

542. Clinical Assessment Family Therapy
This course focuses on training students in the knowledge, skills, and attitudes around assessment in individual, couple and family therapy. Readings, role plays, group activities, and assignments highlight the universality of assessment across types of presenting issues, as well as the content specific to a variety of clinical presentations and areas of concern. Students also focus on proper documentation from a systemic perspective, as well as on skills demonstration to prepare for clinical practicum. (Spring)

543. Psychopathology and Systems
This course reviews comprehensive biopsychosocial assessment and diagnosis of mental illness within a relational and systemic context. Students become familiar with DSM-5 and ICD-10 as well as common screening measures. Students role-play clinical interviewing skills with individuals, couples and families to learn the differences in individual and relationally-informed assessment as well as the importance of cultural and contextual factors. (Fall)

545. Human Development Across the Lifecycle
This course is designed as an introduction to key concepts in human development paradigms; family life cycle theory and clinical applications; lifespan development issues within one’s own family of origin experience; and relevant transgenerational theories, including Bowen, Boszormenyi-Nagy and Framo. (Fall)

548. Family Therapy Ethics and Professional Pracice
This course focuses on the AAMFT ethical code expectations, relevant legal guidelines and professional practice standards within the scope of MFT practice. Students review requirements for state licensure in New York or other states/provinces. Students also address personal issues related to the impact of values, worldview, and culture on the practice of family therapy and demonstrate skills to engage with professional literature in the recognized MFT journals. (Spring)

560. Narr and Integr Approach to Family Therapy
This course focuses on the use of language, storytelling, metaphor and the construction of meaning in the family and in the lives of individuals. Students review literature and study perspectives on how language, lived experiences and storytelling shape people’s lives. The course concludes with a comparative review of major theories and approaches to family therapy. (Fall)
562. Family Therapy Practice
This course prepares students for beginning clinical practice by increasing their practical knowledge, skills, and clinical judgment. Throughout the semester students demonstrate competencies in: clinical practice administration including informed consent and how to communicate with patients outside of session; family therapy interventions across a number of common presenting problems, including depression and anxiety; clinical documentation in the electronic health record; and how to transfer and terminate patients. (Summer)

564. Family Law, Policy and Social Systems
This course focuses on family law, legal contexts/procedures, and the social/family context within which they have evolved and currently exist in the present day. Students study policies related to parental and children's rights in the context of 'the family' and the social systems that intersect with the law. The course attends to the scope of practice, strengths, frustrations and barriers to helping families, as experienced by relevant professional groups. Field trips to family court and social services offices are course assignments. (Spring)

566. Couples Therapy
This course is an introduction to couples therapy. The course reviews principal approaches to couples therapy for common presenting problems. Assessment, relational and systemic formulations, and treatment planning are addressed. Additionally, case discussions invite self-of-the-therapist reflection and awareness of the influence of multiple understandings of culture in the lives of the couple. (Summer)

570. Gender, Human Sexuality, and Culture
This course develops an historical perspective on the issues related to gender, race and culture in family therapy. Students learn the role that gender identity, race, ethnicity, sexual orientation, economic status, language, ability status, and cultural beliefs play in family life and clinical practice. Students engage in a self-directed learning plan as well as the required readings and course activities. (Spring)

572. Family Therapy Research
This course is an introduction to quantitative and qualitative methods in family therapy research, where students learn to critically examine and utilize research findings in clinical practice. Students also review measurement techniques and treatment evaluation methods. Opportunities to build professional research writing skills and poster presentation skills are also provided. (Summer)

574. Child Focused Family Therapy
This course focuses on learning about child development within the relational family system, including an overview of both normal and abnormal development. Students learn how to work clinically with children in the context of family therapy including assessment and diagnosis as well as effective evidence-informed and culturally appropriate treatment. Students demonstrate their knowledge and skills through role play and written case conceptualizations. Students also complete the required NYS mandated reporter training for child protection. (Spring)

582. Families & Violence

584. Masters Project
Students complete a Masters Project as part of the requirements towards graduation, and are required to submit a paper upon completion of the project. The paper is based on an approved Masters Project proposal, with defined learning goals, and should reflect a high level of scholarly work. The project may include, but is not limited to, the following: a case study consisting of an appropriate literature review, an extensive case report and a case presentation; a review essay on a relevant area of research; or an essay on aspects of collaboration with faculty research (i.e., designing instruments, analyzing data sets, developing research protocols, program development). Students who plan to pursue doctoral studies are encouraged to work with mentors and program directors in the Spring of their 1st year to prepare for a masters project that will demonstrate readiness for doctoral level scholarship. (Fall Spring Summer)

586. Masters Project II

587. Clinical Practicum
Prerequisite: Matriculated Students only of the Marriage & Family Therapy Program.
Clinical Practicum provides students with the opportunity to grow in clinical competence and professionalism as an MFT trainee. All students practice in the onsite Office of Mental Health regulated community mental health clinic, Strong Family Therapy Services, in addition to a community placement. Practicum students provide full episodes of care (engagement, assessment, treatment, and discharge planning) that are biopsychosocial, collaborative and culturally-appropriate. In addition, students receive weekly individual and group supervision in accordance with COAMFTE standards. (Fall Spring Summer)

588. Clinical Practicum - Part-Time
Clinical Practicum provides students with the opportunity to grow in clinical competence and professionalism as an MFT trainee. All students practice in the onsite Office of Mental Health regulated community mental health clinic, Strong Family Therapy Services, in addition to a community placement. Practicum students provide full episodes of care (engagement, assessment, treatment, and discharge planning) that are biopsychosocial, collaborative and culturally-appropriate. In addition, students receive weekly individual and group supervision in accordance with COAMFTE standards. (Fall Spring Summer)
Medical Humanities and Bioethics

Associate Professors Baker, Brown, Clark (Director), *Dees, *Demme

Medicine is a science and an art. Caring for a patient is a professional and scientific practice; it is also a personal and profoundly human relationship for both the patient and the practitioner. The field of medical humanities uses the perspectives and tools of humanities and arts disciplines—including literature, ethics, history, visual arts, and others—to study the human contexts of health care.

The Division of Medical Humanities and Bioethics offers a full-time one-year master’s in science degree in medical humanities. In the biopsychosocial tradition of health care education at Rochester, the program provides foundational training in this field. Students study humanities to consider interpersonal perspectives and sociocultural contexts of patients and caregivers and to develop skills that can be applied directly to the practice and teaching of health care.

The program provides students with an opportunity to create their own program of study; engage with students from a wide range of disciplines, careers, and experiences; and develop a close working relationship with interdisciplinary faculty and mentors. The faculty are clinicians in medicine, nursing, and other health care fields, as well as scholars in the humanities.

This one-year degree program fosters interdisciplinary collaborative teaching and learning. It is intended for students, trainees, and professors and scholars in:
1. Health Care Disciplines (medicine, nursing, dentistry, social work, pastoral care, physician assistants, physical and occupational therapy, and allied health fields) who want to develop humanities-based knowledge and skills that can be applied to clinical practice.
2. Humanities, Arts, and Social Science Disciplines (literature, history, philosophy and ethics, visual arts, anthropology, gender, cultural and religious studies, performing arts, etc.) who want to integrate aspects of medicine and patient care into their academic work and teaching.
3. Gap Year Students

Educational Objectives

This degree program provides advanced training and practice in the biopsychosocial approach to understanding health and illness. Through the study and application of humanities to issues in patient care, the students will
1. acquire knowledge of concepts, methods, and subject materials from core humanities disciplines (literature, ethics, history, and visual arts) in relation to current problems and issues in health care.
2. consider multiple perspectives from humanities disciplines on “caring for the patient,” with particular focus on the patient and provider as persons in social and cultural contexts that shape their knowledge, behaviors, and attitudes.
3. develop skills and tools from humanities-based knowledge about patients, providers, and practices that can be applied in clinical practice, studies in scholarly research, and taught in health care education.

Interdisciplinary Team Teaching

The core curriculum is taught by interdisciplinary and interprofessional teams. The teaching faculty are from both clinical and humanities disciplines at the University of Rochester. The core curriculum is taught by health care providers in medicine, nursing, and other allied health fields from the Medical Center and the Division of Medical Humanities and Bioethics, and by scholars in humanities from Arts, Sciences, & Engineering, and faculty from other health care and academic institutions in Rochester and the surrounding area.

Program of Study

The program requires 32 credit hours of graduate-level work with a thesis option of 36 credit hours.

| Fall |
| MHB 410. Bioethics at the Bedside: How Clinicians Think Ethically (4 credits) |
| MHB 420. Stories in Health Care: Clinicians, Patients, and Narrative Medicine (4 credits) |
| MHB 450. Master’s Research Methods: Capstone Planning (4 credits) |
| Elective (4 credits) |

| Spring |
| MHB 430. Visual Arts in Health Care: Framing the Field (4 credits) |
| MHB 440. History of the Body in Science and Medicine: Interdisciplinary Perspectives (4 credits) |
| MHB 495. Capstone Project (4 credits) |
| Elective (4 credits) |

* Primary appointments in another department
CORE COURSES

410. Bioethics At the Bedside: How Clinicians Think Ethically
Most ethical dilemmas in medicine arise at the bedside. Wrestling with these challenging conflicts is a core task of the clinical application of bioethics in medicine and nursing. Using real cases, guided by an interdisciplinary team of practicing clinicians with educators in bioethics and law, this course will examine three fundamental subjects of bioethics that arise in medical practice: informed consent, organ transplantation and death and dying. This course is structured around clinical cases. Students will complete readings to guide discussions around clinical cases. Students will analyse and discuss cases with a variety of members of the health care team – these may include, but are not limited to, physicians, nurses, bioethicists, chaplains, patients and family members. Students will participate in classroom activities to practice the application of knowledge and skills learned. Open to graduate students and upper level undergraduate students. (Fall)

This medical history course explores key developments in scientific knowledge, technologies and cultural ideas about the human body in health and disease. Beginning with Hippocrates and ending with Human Genomics, students will consider the medicalized body from interdisciplinary perspectives, including history, medicine, philosophy, biology, genetics, literature, and visual arts. The different ways in which the “body” has been conceptualized in Western medicine and culture in the past and the present has significant implications for the patient and for the scientists and clinicians who provide treatment and care. Students will discuss the implications for patients, clinicians and scientists using medical cases, patient experiences, scientific debates, and representations of medicine in popular culture. Teaching in this course is interdisciplinary and will present perspectives by scientists, humanities scholars and clinicians in medicine and nursing. (Spring)

420. Stories in Healthcare: Clinicians, Patients and Narrative Medicine
The practice of medicine depends on stories. Patients tell their stories to clinicians; clinicians listen to and interpret these stories. Clinicians then use information gathered from patients’ narratives to guide diagnosis and treatment. In this course, we will identify and develop narrative skills and techniques that clinicians use in practice, through the close study of narratives (poems, fiction, essays, films, etc.) and discussion of key texts in narrative medicine. Topics will include: playing god, death, cancer, professionalism, doctor/patient relationship, and others. (Fall)

430. Visual Arts and Healthcare
As the fields of medicine and healthcare developed, visual arts played important roles in their histories: 1) portraying the human body-inside and out; 2) recording symptoms and progression of disease; 3) representing the practice of medicine; 4) and integrating visual imagery in healing itself. Focus upon the arts in Western culture, the course references examples from the ancient world to the present day in illustrated classroom lectures, followed by visits to area collections. Close-looking and object-based learning, techniques developed in art and history museums, will be introduced and practiced throughout the course, as will approaching works of art from diverse perspectives and considering the impact these have on interpretation. Field trips to area collections with relevant primary materials will include visits to UR’s Miner Library, Memorial Art Gallery, and George Eastman Museum. Joining the course throughout will be curators, historians, archivists, and artists from the Rochester community. (Spring)

436. Health Care and Law

440. History of the Body in Science and Medicine: Interdisciplinary Perspectives
This medical history course explores key developments in scientific knowledge, technologies and cultural ideas about the human body in health and disease. Beginning with Hippocrates and ending with Human Genomics, students will consider the medicalized body from interdisciplinary perspectives, including biology, genetics, humanities and visual arts. Each week we will consider the body in a different historical period to explore the scientific developments and the cultural context of the time. Students will consider the implications for patients, clinicians and scientists using medical cases, patient experiences, scientific debates, and representations of medicine in popular culture. We will compare and contrast the issues of the body in these historical settings with contemporary healthcare “examples” in the 21st C. Teaching in this course is interdisciplinary and will present contrasting and possibly conflicting perspectives by scientists, humanities scholars and clinicians in medicine and nursing. (Spring)

450. Master’s Research Methods
This is an introductory graduate course in research design, methods, data collection, and practices in the health and social sciences. The course will enhance students’ literacy as both a consumer and producer of research. The course is intended to provide a broad foundation for more advanced graduate course work in research methodology and data analysis. (Fall)

494. Special Topics

495. Capstone Project
Students apply knowledge from the humanities disciplines to a question or issue in contemporary U.S. healthcare as a scholarly, research, or educational project. After completing MHB450 Capstone Planning Workshop, students enroll in MHB494 Capstone Practicum to implement their project plan through independent study and individualized supervision with mentors and other content experts, and present their final projects for evaluation. (Spring)
Microbiology and Immunology


Applicants for admission to graduate study in the Department of Microbiology and Immunology should have an undergraduate major in biological or physical sciences. The minimal requirements are general biology, general chemistry, organic chemistry and biochemistry. Applicants seeking the PhD degree are also expected, in addition, to have a year of mathematics and physics. The major goal of the graduate program in microbiology and immunology is to prepare students, through a PhD training program, for a scientific career in one of the several areas included in the broad categories of microbiology, immunology, and virology. During the first year, all students receive basic grounding in biochemistry, with an important emphasis in biology at the molecular and cellular levels. The department offers three tracks (microbiology, immunology, and virology) leading to a PhD in microbiology and immunology. Details about the PhD programs in the various tracks are available from the departmental office on request and on the department website (www.urmc.rochester.edu/microbiology-immunology.aspx).

The MS degree (Plan A) is intended for those whose career goals are in research in microbiology, immunology, or virology. The course program includes microbiology, biochemistry, and additional courses appropriate to the individual’s area of interest and thesis research. The thesis, while not expected to be as extensive as a PhD thesis, must be based on research of significant scientific value. Typically, students complete the degree program in two years.

Individuals who wish to increase their training in microbiology and immunology, but whose career goals are other than research, may earn the MS through Plan B. These career goals might include technical employment or nonuniversity teaching. The program consists of approximately 30 hours of coursework, selected for the most part from courses satisfying the PhD core requirement. After completion of coursework, the student must submit a written essay consisting of a critical review of some area of microbiological literature. Finally, the student will undergo a final oral examination based on the essay and on relevant material covered in courses.

The 3/2 BS/MS program is specially designed for University of Rochester undergraduate students who are majoring in microbiology (BMB). The program is designed to actively prepare graduates for careers in biomedical research by allowing them to earn both BS and MS degrees in five years. While pursuing the MS in immunology, microbiology, virology, and biotechnology, the student will also be immersed in hands-on research and accumulate “real world” skills including critical scientific thinking, scientific communication, group dynamics, problem solving, data analysis, and instruction in drug discovery. The goals are to reflect the interconnectedness and complexity of biomedical sciences as well as the increasing requirement for teamwork in problem solving in the workforce.

The University of Rochester’s MS Technical Entrepreneurship and Management (TEAM) program has partnered with the University’s School of Medicine and Dentistry to design a new and unique version of the traditional TEAM program Biomanufacturing and Therapeutic Development (TEAM-BMTD). The goal of this program is to train the next generation of leaders in biomanufacturing and drug development. This will be achieved by providing training in the principles of entrepreneurship and management and instruction with current techniques and methods used in biomanufacturing, drug discovery, and therapeutic development. Students completing this program acquire a unique combination of skills and the ability to speak the languages of both business and biomedical science. As a result, they will have a significant competitive edge in the job market—and enhanced career marketability in the pharmaceutical and biotechnology industries.

The Department of Microbiology and Immunology, the Simon Business School, and the Hajim School of Engineering & Applied Sciences have pooled their strengths to design this program.

400. The Microbiome

401. Biology of Hiv/Aids
Prerequisites: Core first-year graduate courses (Biochem., Cell Bio. & Mol. Bio.) will be required for graduate students taking the course. Undergraduate students will need the approval of the Course Director and some coursework in Cell Biology and Molecular Biology

This introductory course provides an in-depth exposure to key issues in HIV/AIDS research including molecular biology and the lifecycle of the virus, transmission and pathogenesis, immune responses, antiviral, microbicides and vaccines, reservoirs and attempts to cure HIV infection. This is 1 credit hour course will be offered Friday June 3 to July 29, 2011 in Microbiology and Immunology conference room 2-1121. Please note: This course is mandatory for all graduate students who are appointed to the HIV T32 pre-doctoral training program. For more information, contact Carrie Dykes, Ph.D. or Stephen Dewhurst, Ph.D. Carrie_Dykes@urmc.rochester.edu Stephen_Dewhurst@urmc.rochester.edu (Summer)
402. Writing in Microbiology

An integrated scientific communication course with an emphasis on communication through writing. Several key writing platforms are covered, including peer-reviewed papers, research proposals, scientific reviews, and articles targeted to the general scientific community and the general reader. An essential component of successful scientific writing is skill in understanding the writing of others, and a section on “how to read and critically evaluate peer-reviewed publications” is incorporated into the course. (Spring)

403. Drug Discovery

This course is designed to provide graduate-level and senior undergraduate students with an introduction to current Drug Discovery processes, with special emphasis placed on antimicrobial development. The course is taught by University of Rochester faculty with drug discovery research programs as well as internationally recognized leaders in requisite fields of pharmaceutical practices from biotechnology and pharmaceutical industry. Topics covered include, but are not limited to, bioinformatics-based drug target identification, high-throughput screening approaches (and pitfalls), medicinal chemistry, hit to lead optimization, clinical trial design, and intellectual property and portfolio management. (Spring)

404. Intro to Emerging Pathogens

Prerequisite: Approval of Course Director

The past several decades have been marked by a rise in the emergence of exotic pathogenic microorganisms and their introduction into the human population. This course documents the history of the appearance and spread of these emergent pathogens, and discusses mechanisms that govern the selection of new pathogenic strains and species. The evolution of host pathogen relationships is also considered as well as the role of environmental change in the development of new emergent and re-emerging pathogens. Current and future technological advancements, such as research into the design of biological weapons and the construction of synthetic life forms are discussed with respect to potential risks for the emergence of novel infectious agents.

405. Microbiome

406. Biomanufacturing

This course is designed to provide both undergraduate & graduate level students with an introduction to current aspects of the manufacturing of Biopharmaceuticals from industrial techniques produced through a variety of commercially relevant bioprocesses. MBI 406 provides an overview of the product life cycle for biological products used for the treatment or prevention of human disease. Specific topics will include biomanufacturing background, quality assurance, regulations, procedures, proper techniques and documentation. A tour to the Upstate cGMP facility is included as an example of a fully validated biomanufacturing facility for the production of cell therapy products providing examples of upstream and downstream processing. Careers associated with all phases of the product life cycle are discussed as lectures by USCGF Facility staff and visiting industry professionals (MBI406 Fall 2017 already confirmed: Biogreen, Bristol Myers Squibb, Biomanufacturing Training & Education Center, Novozymes and Gencure)

407. Practicum

Practicum is a planned, supervised and evaluated practical experience in either biomanufacturing or small molecule therapeutic development; placement is coordinated by the course directors and is determined by the student’s academic goals and professional interests. The biomanufacturing practicum will take place in the UR cGMP sterile environment facility for the testing, production and packaging of biopharmaceutical products. Students electing to participate in a small molecule therapeutic development practicum will be placed in a research laboratory that is conducting a phase of drug development that best aligns with the student’s career objectives. Each Practicum will help the student translate into practice the concepts and principles taught in the classroom; offer opportunities to engage in activities that will advance a student’s career potential and goals; and provide opportunities for networking with professionals in the field, for references and for future job opportunities. (Fall/Spring)

414. Microbial Pathogenesis

Prerequisite: MBI 220/221

The course provides an examination of host-pathogen interactions and details the mechanisms that microbes use to evade the immune response and cause disease. Topics include bacterial colonization, invasion, antigen variation, toxin production and mode of virulence factor action, collectively aimed at providing a molecular level understanding of microbial pathogenesis. Pathogenic fungi are also briefly covered, as are host defense mechanisms. Classes are conducted using a combination of formats: formal lecture, discussion, critical thinking and review of primary literature. (Graduate students must register for MBI 514 seminar). (Fall)

421. Microbial Genetics and Physiology

Prerequisite: MBI 220 (or similar course) or BIO198 (or similar course)

This course provides an in-depth examination of representative genetic systems in bacteria and bacterial viruses. Emphasis is placed on the methods of genetic analysis used to study biological function. The material covered includes: the nature of bacterial variation, processes affecting gene synthesis and integrity, the nature of gene transfer in bacteria, the regulation of gene expression in prokaryotes and genomic approaches to the study of microbial genetics. (Graduate students register for MBI 521 Seminar) (Spring)

431. Microbial Physiology

This course provides a survey of microbial physiology with emphasis on metabolism, regulation, cell walls, membranes, biofilms, stress responses, and adaptation to extreme environments.
The class meets twice per week for two lectures of 75 minutes each. Extensive handout materials are provided, and readings are from the current literature. Doctoral students must register for MBI 531 seminar. Offered Fall alternate years (Fall)

456. General Virology
Prerequisite: Basic Biochemistry or Molecular Biology.

The General Virology course provides an introduction to animal virology, with emphasis on human diseases. Topics covered in the class include: general properties of viruses, virus structure, molecular mechanisms of virus replication and gene expression, virus-host cell interactions, pathogenesis, vaccines, antivirals, and viral immunology. Viruses discussed include: Herpes, Pox, Measles, Ebola, Influenza and HIV (Spring)

473. Immunology
Prerequisites: BCH 250 and BIO 198 or equivalent. BIO 202 is also recommended.

This lecture-based course will cover basic concepts in development and function of the immune system, including innate immunity and inflammation, adaptive T and B lymphocyte responses, immunity to infection, vaccination, tumor immunotherapy, transplantation, allergy, and autoimmunity. Small group meetings will be held weekly to discuss open-ended problems based on recent lectures. Students will be evaluated by three exams. (Fall)

501. Microbiology and Immunology Seminar Series

A program of seminars held once a week and conducted by graduate students is presented each semester. Continuous registration is required of all Ph.D. students in the Department of Microbiology and Immunology; attendance of Departmental faculty is also expected. The objective is to train students to present their research in a form accessible for a non-specialized scientific audience. Each student starting from her/his second year is required to present until the PhD defense. The first presentation should last 20 minutes, followed by 10 minutes for questions. It should include background information, rationale, experimental design, and relevance of the project; preliminary data are welcome but not essential. The following presentations should be formal, 45 minute long, “research in progress” seminars allowing 10-15 minutes for questions. Each presenter is expected to answer questions from other students and from faculty in the audience. Confidential evaluation provides feedback to presenters. (Fall Spring)

506. Scientific Writing in Research

Students complete a formal report on each of their three lab rotations. Reports are approximately 10 pages in length, and following the format of a scientific paper. Reports are evaluated, with constructive criticism and written feedback provided by the faculty rotation mentor, and at least one additional faculty member not directly involved with the project. All reports are revised in consultation with the faculty evaluator and course director. (Fall Spring)

507. Lab Rotations

Consists of a series of laboratory experiences, each of approximately eight weeks, in laboratories of several faculty members. Usually, Ph.D. students are expected to enroll for three rotations (eight hours of credit) (Fall Spring)

514. Microbial Pathogenesis Seminar

This is the concurrent seminar required for graduate students registering for MBI 414. (Fall)

515. Advanced Immunology
Prerequisite: MBI 473

Focus is on issues related to antigen-specific immunity. Course stresses the molecular aspects of antigen-specific recognition and cell-cell interactions for both the development and activation of T and B cell lineages. Key checkpoints in development and activation are emphasized as well as important regulatory mechanisms in lymphocyte activation and function. Factors that control protective immune responses to pathogens and autoimmunity are discussed. Topics in the course are presented primarily within experimental frameworks and scientific literature. Topics are introduced using data from original papers in order to analyze underlying hypotheses, experimental strategies, and interpretation of experimental results. Discussion in class, take-home problem sets, and in-class exams, the course encourages students to think critically, integrate diverse areas of knowledge, and develop an appreciation of the experimental approaches that have been and that are currently used to move the field of immunology forward (Spring)

518. Critical Thinking in Research
Prerequisite: The core first-year graduate courses (Biochemistry, Cell Biology, and Molecular Biology) are required for graduate students taking this course.

Course is designed to provide students with a forum for discussing their research projects in great depth with their student colleagues, including the underlying basis for their studies, experimental design, data, interpretation, future studies, and challenges encountered in the execution of their studies. In addition, it provides participants with an opportunity to begin the process of developing their own “personal research network” by actively interacting with their colleagues, which will be essential for future success in their research careers. The course meets at least seven times during each semester, for 90 minutes. The course is intended for predoctoral trainees in their second year (or later) of graduate training. It is mandatory for all graduate students who are supported by institutional NIH Training Grants awarded to the department. The course is also open to students who are beginning their second year of studies and wish to be considered for appointment to these Training Grants in the future (Fall)

519. Experimental Design and Analysis

In the first weeks, students have round table discussions to share their experiences, goals and priorities for Research Rotations,
including rationale and process of choosing rotation research lab / mentors and a final thesis advisor and laboratory. Faculty and more senior students are also invited into the class to provide their perspectives on rotations and graduate training. Each student enrolled in the class will first present his/her rotation project including such issues as question(s) addressed in the project, rationale for the experimental approach taken, the path the project may take as well as key literature relevant to their rotation project. Later in the semester, each student will present data obtained from the rotation for discussion and feedback. Participation of all students in the discussion of research projects and sharing of ideas throughout the class is expected. (Fall)

521. Microbial Genetics Seminar
This is the concurrent seminar required for graduate students registering for MBI 421. (Spring, alternate years)

531. Microbial Physiology Seminar
The seminar course uses a journal club format in which papers from the current literature are used for student-led discussions relating the subject matter of the paper to material covered in the MBI 431 lecture. Offered with MBI 431 (Fall)

540. Topics in Immunology
Prerequisite: MBI 473 or equivalent

570. Advanced Topics in Molecular Microbiology
Prerequisite: MBI 473 or equivalent
Seminar and journal club series required for all microbiology students. This course involves the discussion of the primary literature to explore the molecular mechanisms underlying microbial pathogenesis. Students are required to present papers from selected topics and participate in discussion of the presented material. (Fall Spring)

573. Immunology Seminar
Prerequisite: MBI 473
This discussion course is taught in conjunction with MBI 473 Basic Immunology and covers the same topics thus providing an overview of immunology. The course is based on critical reading of original journal articles. Two-four papers are read each week with oral presentation and discussion by the students. Exams: Weekly oral presentations (Fall)

580. Immunology Research in Progress
Prerequisite: MBI 473
Consists of the Immunology Journal Club (meets on hour per week). Students read and discuss recent papers from the immunology literature. The second part consists of attendance at the weekly one hour Immunology Research-in-Progress Seminar Series (Fall Spring)

581. Oral Microbiology
The course is focused on infectious diseases that occur in the human mouth. Dental caries, periodontal disease, fungal and viral infections are discussed in the context of physiology, genetics and pathogenic mechanisms. Current experimental approaches for the study of oral microbiomes and their interaction with the human host will be discussed. There is no textbook required for the course, but there will be handouts and assigned reading from the literature for each session. (Fall, alternate years).

588. Virology Research Seminar
This course provides a forum for discussion of ongoing work in research laboratories at the University of Rochester as it pertains to virology. Topics include vaccine research, drug development and testing, gene therapy, cellular and molecular virology. (Fall Spring)

589. Adv Topics in Virology
Advanced topics in virology are investigated in a discussion course. Previous topics include basic virus structure, replication, assembly, virus-host interaction, anti-viral therapy, vaccine design, and viral transcription regulation. Students present and critique the literature. (Fall)

595. PhD Research
Credit to be arranged
Research may be undertaken in virology, general medical microbiology, animal parasitology, immunochemistry, genetics, physiology, bacterial cytology, and cellular immunology. (Fall Spring)
Neuroscience


Neuroscience Graduate Program (multidisciplinary)


Associate Professors 13Bennetto, Briggs, 12Brown, 7Cantlon, 7Crane, Dickerson, Freedman, *Fudge, 3Halterman, 4Holt, 4Kammermeier, 4Kiernan, 4Lalor, 4Libby, 7Luebke, 7Majewska (Director), 11Mayer-Pröschel, 11Nehrke, 1Portman, 13Pröschel, 1Romanski, 12Seidman, 4White, *Xia

Assistant Professors 17Ghaemmaghami, 1Haefer, 12Henry, 1Hunter, 19Lin, 1MacLean, 1Maddox, 1Mahon, 1Mitchell, 7Padmanabhan, 7Poletti, *Schallek, <Singh, 1Tadin, 19Takano

The Department of Neuroscience (formerly the Department of Neurobiology and Anatomy) is recognized for its excellence in research programs and for its commitment to teaching and leadership in both graduate and medical education. Over 40 faculty (primary and joint) are actively engaged in research on the structure and function of the nervous system across several levels of inquiry. Areas of interest cover a broad spectrum, including sensory, motor and integrative systems, cell signaling and transmission, development and aging, neurobiology of disease, learning and plasticity, neuro-engineering, and computational neurobiology. Extensive state-of-the-art instrumentation and methodologies are available for investigators, students, and staff, both within labs and across a set of departmental research cores. Close interactions among departments and centers sharing interests in neuroscience ensure that this discipline holds a leading presence throughout our unified medical and college campus, while the Department of Neuroscience remains central to Rochester’s research and teaching programs in the neural sciences. For students as well as fellows and visiting faculty, this translates into a highly attractive environment for training and career development.

An enduring departmental role continues to be its commitment to education. This commitment includes extensive participatory and leadership roles in medical, graduate, and undergraduate curricula at the University of Rochester. Faculty in the department have received a continuous stream of awards for teaching and leadership efforts over the years, including a fifth of all Dean’s Teaching Scholars Awards, and recurrent commendations conveyed by students.

The department plays a central role in graduate education within the neural sciences community at the University. In addition to our own Neuroscience Graduate Program, commitments include extensive instructional and leadership roles in the graduate programs of brain and cognitive sciences, biomedical engineering, and others. Interconnections between different levels of clinical education and graduate education are also strong.

The Neuroscience Graduate Program offers two PhD degrees: (1) Neurobiology and Anatomy and (2) Neuroscience.

The Department of Neuroscience remains central to Rochester’s research and teaching programs in the neural sciences. For students interested in the characteristics of, and mechanisms underlying, the nervous system, from the molecular and cellular to systems level, active learning is fostered through participation in the Neuroscience Journal Club and Student Seminar and through a series of laboratory rotations with faculty selected by the student. During the first year, students engage in a rigorous curriculum in cellular and systems neuroscience that builds a solid foundation for subsequent, more specialized coursework tailored to the individual career and research interests of each student. In addition, first-year students complete three laboratory rotations that, through active participation in a research project, provide an insider’s view of the research interests, laboratory environment, and mentoring style of potential thesis advisors.

At the end of the first year, students choose a PhD degree track (neuroscience or neurobiology and anatomy) and thesis advisor and begin developing and carrying out their dissertation research. Training in subsequent years occurs largely through active participation in laboratory research, journal clubs, and seminars, and at local, national, and international scientific meetings. Students are awarded the PhD degree upon successful defense of scholarly research described in a publishable dissertation.

1. The departmentally based degree in Neurobiology and Anatomy is particularly well suited to students in the University’s MD/PhD program and to PhD candidates interested in the characteristics of, and mechanisms underlying, function and dysfunction of the nervous system. Mentors for this degree are primary faculty from the Department of Neuroscience. The program is specifically directed toward preparation for academic careers within a medical school setting, where teaching in medical and graduate school...
curricula comprises a strong component of faculty mission, and where research interests include systems, integrative, and translational/clinical attributes of neural science. To those choosing the neurobiology and anatomy PhD track, a rare opportunity is offered—students choose one of the two medical school courses associated with the department, depending upon interest. Human Structure and Function includes gross anatomy, yielding an appreciation of the peripheral nervous system and its diverse interactions with numerous functions of the body, while Mind, Brain, and Behavior approaches neuroscience from a distinctly human perspective with emphasis on clinical implications and mechanisms. Additional electives are chosen to provide a more specialized emphasis as students approach their extended research training. Graduate students in neurobiology and anatomy are encouraged to exploit the multidisciplinary talents of our faculty in basic and clinical disciplines to achieve the research goals of their dissertation projects. Numerous collaborative research programs offer opportunities with colleagues in associated departments. Finally, teaching requirements and opportunities are prominent in the program, in order to instill the confidence necessary to impart knowledge to others, and to prepare students for their eventual roles as teacher/researchers of the future.

2. The PhD in Neuroscience provides a comprehensive, research-intensive training experience for students seeking a PhD degree in the study of the nervous system. The PhD is an interdepartmental degree with over 60 faculty members serving as mentors for students. Faculty represent basic science and clinical departments and centers from the School of Medicine and Dentistry and the schools of Arts, Sciences & Engineering. Faculty research interests span all major themes in neuroscience including neural cell signaling and communication; learning, memory, and adaptive plasticity; neurobiology of disease; neurodevelopment and aging; neuroengineering; neurogenetics; sensory, motor, and integrative systems neuroscience; and neuroregeneration and repair. Collaborations across these themes are a hallmark of the program, providing students the opportunity to design thesis projects without regard to traditional boundaries.

NEUROBIOLOGY AND ANATOMY

405. Hearing and Balance
Designed as a survey course on auditory and vestibular structure, function and disease with an overview perspective of select peripheral and central auditory vestibular system disorders that are prevalent in the pediatric and adult populations. Factors and issues related to diagnostic and rehabilitative strategies and outcomes will be examined. The course is presented in a lecture format, supplemented by handouts, visual media, and internet/web based links.

411. Cellular and Molecular Biology Foundations
Prerequisite: You must register for a recitation when registering for the main section.
Molecular biology, biochemistry, and genetics that are required to understand the biomedical and broader biological issues that affect our lives. (Fall)

491. Master’s Readings

493. Special Topics

495. Master’s Research

511. Cell and Molecular Foundations

512. Cellular Neuroscience
This course aims to provide students with an advanced understanding of the ionic, biochemical, molecular, and cellular properties of the nervous system. The course begins by discussing the electrical properties of neurons, the molecular properties of ion channels, and the functional organization of receptors and channels at the synapse. Subsequent lectures cover the molecular and cell biology of neurotransmission, including the major neurotransmitter/receptor systems, receptor-mediated signal transduction, and sensory transduction. The final section discusses the molecular and genetic processes that govern development of the nervous system. (Fall)

513. Neuroinflammation
This course will examine the role of inflammation in the central nervous system and will highlight common mechanisms of response to a variety of neural insults, including autoimmunity, trauma, neurotoxicity and neurodegeneration. At the end of this course students will have an appreciation for the roles of glia, the acquired immune system and the innate immune system play in response to neural insults in the unique “immunoprivileged” environment of the CNS. Course offered during even years. (Spring)

515. Neural Control of Behavior

518. Introduction to Neuroengineering
Prerequisites: BME260, strong math/computing skill recommended or permission of instructor. Recitation for this course will be required.
Quantitative studies of neural responses at the cellular, circuit, and systems levels. Analytical and computational modeling of neurons, including nonlinear behavior of neurons and neural circuits. Neural coding of information by single cells or neural populations. Applications of neural networks. Techniques for recording and monitoring neural activity, and applications of neural recording and stimulation to neural prostheses. (Fall)
521. Journal Club

The course provides first and second year students with experience in critical thinking and experimental design through the analysis of historic and important recent findings in the neuroscience literature. The selection of journal articles is typically coordinated with topics being taught concurrently in the Cellular and Systems Neuroscience courses.

522. Student Seminar

Student seminar provides a friendly forum for students to develop and refine their presentation skills and to practice fielding questions concerning their research. Students deliver an oral presentation on their research each year they are in the program. Faculty and students in the audience evaluate the talks and provide written feedback to the presenter. (Fall Spring)

525. Mind, Brain, Behavior

Prerequisite: Permission of the instructor.

This nine-week course provides a multidisciplinary overview of the structures, functions, and dysfunctions of the human nervous system, integrating both basic and clinical sciences. Basic science portions of this course include the disciplines of neuroanatomy, neurophysiology, neuro- and psychopathology, and neuro- and psychopharmacology. The basic science material is fully integrated with the clinical disciplines of neurology and psychiatry. Overview lectures, problem-based learning sessions, and laboratory exercises introduce students to the basic and clinical sciences underlying neurological and psychiatric disorders. This course provides a foundation for students interested in understanding and teaching neuroscience in undergraduate, graduate, allied health, and medical school settings. (Fall)

526. Human Structure and Function

Prerequisite: Permission of the instructor.

The course in Human Structure and Function (HSF) is designed to teach the essential facts, mechanisms and concepts of human biology from an integrated perspective, with a focus on clinical application. The basic concepts of human structure, from the cell to the organism, and the key mechanisms of cellular and organ system function, form the foundation of clinical medicine. Moreover, your introduction to structure-function relationships is your introduction to the language of medicine.

531. Integrative Neuroscience

Prerequisites: MUST REGISTER FOR NSC 511-Human Brain Anatomy. 4 exams (3 on Mondays), submitted questions on readings, class participation

Approaches & Techniques: Experimental approaches to relating brain & behavior; Neurophysiological techniques; Computational approaches; Imaging; Neuroanatomical techniques. Sensory Systems: Somatosensory system; Auditory system. Visual System: Retina & retinal projections; LGN & striate cortex, extrastriate cortex; Vestibular system; Chemical senses. Motor Systems: Muscles & spinal cord; Motor cortex & descending control; Neural control of eye movements. Basal Ganglia: Structure & function; cerebellum. Regulatory and Integrative Systems: Autonomic function; Hypothalamus; Sleep, arousal & circadian rhythms; Reward systems/Basal ganglia; Brain mechanisms of emotion. Cognitive Neuroscience: Brain plasticity; Learning & memory; Neural mechanisms of attention; Neural basis of spatial cognition & decision-making; Frontal lobe; Reward & decision-making; Language & brain. (Spring)

581. Teaching Tutorial - Human Structure and Function

Prerequisite: Ranked in the top 80% of HSF.

Provide lab instruction, participate in small-group teaching, attend lectures and staff meetings, and assist in preparing and grading examinations in our first year Human Structure and Function course. This elective is designed for students who wish to review their anatomy, histology and physiology, or for students who wish to gain teaching experience in anticipation of an academic career. (Fall)

583. Teaching Tutorial - Mind, Brain, Behavior

This experience is designed to provide an opportunity for students to acquire and develop skills in teaching and course management in neurobiology (particularly related to Mind, Brain, and Behavior). Students are expected to attend staff meetings, provide instruction in the laboratory, bear responsibility for small group teaching, prepare and deliver formal lectures, assist in the preparation and grading of examinations, and participate in staff evaluation sessions. Although designed primarily for advanced graduate students in the Department of Neuroscience, other graduates may elect this experience with permission of the instructor. (Fall)

591. PhD Readings

Students may design an independent study course with one or more faculty members. Course will focus on a specific and well defined topic. Instruction will center around the primary literature. (Fall Spring)

593. Special Topics

595. PhD Research

Opportunity is afforded for qualified students to undertake research under the direction of members of the faculty. (Fall Spring)

NEUROSCIENCE

493. Master’s Essay

495. Master’s Research

503. Neuroscience Student Seminar

The Neuroscience Student Seminar provides a forum where students deliver, at least once per year, an oral presentation related to their research. The course is designed to help the students
develop their communication skills and ability to give effective and focused presentations. (Fall Spring)

**511. Human Brain Anatomy**

This short introduction to human brain anatomy is based on a series of laboratories developed for medical students. The major goal is to gain an understanding of basic brain structures from standpoints of anatomy, organization, and function. Information about brain vasculature and the ventricular system will also be covered. Basic concepts learned in these exercises will be further developed by lectures in the class. Because we are examining human brain, some clinical material will be presented (e.g. strokes). However, the emphasis will always be relating structure to function rather than diagnosing neurological conditions. (Spring)

**512. Cellular Neuroscience**

This course aims to provide students with an advanced understanding of the ionic, biochemical, molecular, and cellular properties of the nervous system. The course begins by discussing the electrical properties of neurons, the molecular properties of ion channels, and the functional organization of receptors and channels at the synapse. Subsequent lectures cover the molecular and cell biology of neurotransmission, including the major neurotransmitter/receptor systems, receptor-mediated signal transduction, and sensory transduction. The final section discusses the molecular and genetic processes that govern development of the nervous system. (Fall)

**513. Introduction to Functional Magnetic Resonance Imaging (fMRI)**

*Prerequisite: Prior programming experience.*

The core focus of the course will be on how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing. There will also be a component, about 20% of the class, on the big picture aspects of MRI physics and physiology which make fMRI possible. (Spring)

**515. Neuroscience Journal Club**

This course focuses on both historic and recent findings in the neuroscience literature, and provides experience with reading scientific papers, experimental design, data analysis, and critical thinking. The readings are often coordinated with materials being taught in the core Cellular and Systems Neuroscience courses.

**525. Biology of Neurologic Diseases**

*Prerequisites: Course for graduate students in NGP who took NSC 512 & are taking NSC 531 concurrently, 1st year of the cellular & molecular pharmac. and physiol. curriculum (IND408, IND409, IN D410, PHP403, PHP404). Others must secure the permission of the course director.*

Lectures cover both clinical and basic science aspects of each disease state. The class is offered during even years and topics may vary. Class may include discussion of: Alzheimer’s, Amyotrophic lateral sclerosis (ALS), Autism, CNS trauma (spinal cord injury/traumatic brain injury), Dystonia, Glaucoma, Huntington’s, Mood disorders, Multiple sclerosis: Myasthenia gravis, Neuroblastoma/Brain Tumors, Parkinson’s, Peripheral neuropathy (Charcot-Marie-Tooth), Stroke. (Spring)

**531. Integrative Neuroscience**

*Prerequisites: MUST REGISTER FOR NSC 511 - Human Brain Anatomy; 4 exams (3 on Mondays), submitted questions on readings, class participation.*

Approaches & Techniques: Experimental approaches to relating brain & behavior; Neurophysiological techniques; Computational approaches; Imaging; Neuroanatomical techniques. Sensory Systems: Somatosensory system; Auditory system. Visual System: Retina & retinal projections; LGN & striate cortex, extrastriate cortex; Vestibular system; Chemical senses. Motor Systems: Muscles & spinal cord; Motor cortex & descending control; Neural control of eye movements. Basal Ganglia: Structure & function; cerebellum. Regulatory and Integrative Systems: Autonomic function; Hypothalamus; Sleep, arousal & circadian rhythms; Reward systems/Basal ganglia; Brain mechanisms of emotion. Cognitive Neuroscience: Brain plasticity; Learning & memory; Neural mechanisms of attention; Neural basis of spatial cognition & decision-making; Frontal lobe; Reward & decision-making; Language & brain. (Spring)

**547. Topics Computational Neuro**

**581. Teaching Tutorial in NSC**

Students serve as a teaching assistant for one semester (usually in year 2 or 3) for either an undergraduate neurobiology course on River Campus or an anatomy or neuroscience course in the Medical School for one semester. Additional opportunities to gain teaching experience are available to interested students. (Fall)

**590. Lab Rotations in NSC**

A series of 3-4 laboratory rotations (each lasting about 10 weeks) provides 1sr-year students with an insider’s view, through active participation in a research project, of the research interests, lab environment, and mentoring style of potential thesis advisors. Students have the option of completing their first rotation during July and August the summer before their first semester of graduate school. (Fall Spring Summer Winter)

**591. PhD Readings**

Students may design an independent study course with one or more faculty members that does not include the advisor. Course will focus on a specific and well defined topic. Instruction will center around the primary literature. (Fall Spring)

**592. Journal Club**

The course provides first and second year students with experience in critical thinking and experimental design through the analysis of historic and important recent findings in the
neuroscience literature. The selection of journal articles is typically coordinated with topics being taught concurrently in the Cellular and Systems Neuroscience courses. (Fall Spring)

593. Special Topics

595. PhD Research

Opportunity is afforded for qualified students to undertake research under the direction of members of the faculty.

Center for Oral Biology

Professors Quivey (Director), Hsu, *Shuttleworth, *Yule
Associate Professors *Haidaris, Ovitt

The principal objective of the Center for Oral Biology is to train the next generation of scientists for academic careers in research related to oral health and disease. In pursuit of these aims, the center cooperates closely with the basic science departments of the School of Medicine and Dentistry, Arts, Sciences & Engineering, and with the Eastman Institute for Oral Health.

Graduate students who hold appointments in the Center for Oral Biology may work for the PhD degree in disciplines including, biochemistry, biology, biophysics, genetics, microbiology and immunology, neurobiology and anatomy, neuroscience, pathology, pharmacology, physiology, toxicology, and translational biomedical science. Entrance requirements are in accordance with the policies of the individual departments, and programs. The PhD candidate is registered in the department or program in which the degree is administered. Classes and seminars are attended, and a research program directed toward the solution of a problem pertinent to oral science is carried out. Guidance and supervision are available from the faculty members of the Center for Oral Biology, consultants on the staff, and members of the collaborating departments and centers.

The Training Program in Oral Sciences provides financial support for pre- and postdoctoral (DDS or PhD) fellows to receive training for three to five years. The objective of the program is to prepare creative, imaginative, and highly skilled professionals in the field of oral biology.

The courses available to support training are quite broad in their diversity.

* Primary appointment in another department
Pathology and Laboratory Medicine


The Cell Biology of Disease (CBD) Graduate Program is offered through the Department of Pathology and Laboratory Medicine and leads to a PhD in pathology. While the program is sponsored by the Department of Pathology, the participating faculty are drawn from at least 16 departments throughout the University of Rochester Medical Center. This provides diverse education and research experiences and thesis opportunities for the student. The CBD Graduate Program trains students in understanding and developing treatments for human disease. The program is multidisciplinary in nature, drawing on faculty expertise in all aspects of disease biology including defining the molecular mechanisms underlying pathology, developing model systems, “omic” sciences (genomics, transcriptomics, proteomics, lipidomics, metabolomics, and microbiomics) and designing therapeutic interventions using regenerative biology, forward pharmacology, and rational drug design. Students are generally free to work with any faculty in the University of Rochester Medical Center whose research focuses on disease biology or basic cell biological mechanisms that are critical for pathogenesis. Students who complete the Cell Biology of Disease Graduate Program receive a PhD in pathology and go on to rewarding careers in academic, medical, industrial, nonprofit, and governmental settings.

The first year of the program is designed to give students a strong foundation in biochemistry (IND 408), cell biology (IND 409), molecular biology/genetics (IND 410), and in fundamentals of pathobiology (PTH 509/510). The course requirements are common to most degree programs in the first year and afford the students maximum flexibility. At the end of the first year of study, after successful completion of course requirements and three lab rotations, students designate a thesis advisor. The thesis advisor need not be a member of the CBD Graduate Program faculty but must provide a strong training and educational environment. Students follow a disease-oriented curriculum in elective studies and in advanced coursework during the second year.

The CBD program has a diverse faculty, providing students many exciting research opportunities. Faculty research interests include cellular structure and function, nuclear receptors, gene regulation, cell-cell interactions, chemotaxis, extracellular matrix, genetic and molecular analysis of chromosome structure and gene expression, growth factors, lipoprotein structure and function, oncogene and tumor susceptibility, neuronal function and death, and systems biology. Diseases under active investigation include diabetes; obesity; cardiovascular disease; Alzheimer’s disease; traumatic brain injury; stroke; ocular disease; infectious disease; autoimmune disorders; musculoskeletal disorders; breast, prostate, brain, and bladder cancer; and arthritis to name just a few. To study these diseases, students use a wide variety of advanced cellular and molecular biological techniques. Importantly, students are encouraged to take a multidisciplinary approach to study these diseases so as to make important scientific insights and to prepare them for future scientific endeavors.

491. Master’s Readings

493. Special Topics

495. Master’s Research

504. Current Topics in Experimental Pathology

Prerequisite: Credit: One hour.

This course uses the seminar format to introduce students to diverse experimental and intellectual approaches to studying disease processes. Students present their current research in a peer and mentor review setting where students gain experience in oral presentation skills. This series is held Wednesdays at 4:00 pm. (Fall Spring)

507. Cancer Biology

Prerequisites: Permission of the course director (e-mail Dr. Lee or Dr. Xu). Course Directors: Yi-Fen Lee and Lei Xu.

The lectures will provide historical perspectives of cancer incidence, treatment, and early scientific inquiry as a foundation for understanding the current state of cancer research. Leading basic and translational scientists will discuss the genetic basis of cancer in both familial cancer syndromes and acquired somatic mutations. Research on the normal cellular functions such as cell cycle control, apoptosis, and signal transduction that become aberrant in cancer progression will also be discussed. Additionally, the mechanism of chemical and viral induction of cancer will also be explored. The second half of the course will focus on clinical identification and treatment of cancer as well as the mechanism of therapeutic action in prevention of carcinogenesis. Lectures from leading clinician-scientists will provide insight for cancer treatment with goals of understanding the human impact of the disease and identifying common themes, as well as distinctive characteristics of cancer. (Spring)

* Primary appointment in another department
509. Pathways of Human Disease
Prerequisite: four hours. Prerequisite: permission of the course director.

This two-semester course is the signature course of the graduate program in Pathology. Its objective is to provide students with an introduction to human disease processes with an emphasis on the molecular and genetic mechanisms of disease. Students will learn the basic anatomy, histology, and physiology of all major organ systems in the context of examples of human disease. They will complete the course with an understanding of the basic principles of human disease processes at the whole animal, organ, cellular, and molecular levels. They will also gain insight into current applications and limitations of modern diagnostic medicine and the importance of basic translational research. Lectures are complemented by interactive labs and journal clubs to expand on what is taught in class. In journal club sessions, students will learn to critically read and evaluate scientific papers and will gain experience in presenting to their peers. (Fall)

510. Pathways of Human Disease
Prerequisite: four hours. Prerequisite: permission of the course director.

This two-semester course is the signature course of the graduate program in Pathology. Its objective is to provide students with an introduction to human disease processes with an emphasis on the molecular and genetic mechanisms of disease. Students will learn the basic anatomy, histology, and physiology of all major organ systems in the context of examples of human disease. They will complete the course with an understanding of the basic principles of human disease processes at the whole animal, organ, cellular, and molecular levels. They will also gain insight into current applications and limitations of modern diagnostic medicine and the importance of basic translational research. Lectures are complemented by interactive labs and journal clubs to expand on what is taught in class. In journal club sessions, students will learn to critically read and evaluate scientific papers and will gain experience in presenting to their peers. (Spring)

571. Molecular Basis of Disease
Prerequisite: Fall semester. Two 1 1/2-hour session per week.
Credit: Three hours. Course Director: Catherine Ovitt

This course provides translational medicine-oriented lectures to help students understand the utilization of molecular, cellular and genetic approaches to investigate human diseases and disease-related animal models. Significant emphasis will be placed on the current understanding of disease processes, limitations, and strategies for innovative experimentation that should lead to breakthrough discoveries and cures. Discussions will address various diseases including but not limited to cardiovascular, neurological and musculoskeletal abnormalities, autoimmunity, endocrine defects and cancer. The course is composed of lectures and journal club style paper presentations. Students will be assigned scientific papers of interest that they will present and discuss with their peers at the second session provided by each faculty. (Fall)

573. Internship

574. Nuclear Hormone Receptors

591. PhD Readings

593. Nuclear Hormone Receptors
Prerequisites: permission of the course directors (email). Course Directors: Shuyuan Yeh and Mesut Muyan

This course aims to provide an understanding of the actions of nuclear hormone receptors in physiology and pathophysiology of many tissues. The dynamic regulation of target tissue physiology relies on circulating hormones, such as estrogen and androgen, that act through their cognate receptors. The nuclear hormone receptor superfamily includes steroid hormone receptors, such as AR, ER, GR, and PR, as well as receptors for thyroid hormones, retinoids, and vitamin D, and different orphan receptors of yet unknown ligands. Nuclear hormone receptors are ligand-inducible transcription receptors with specific DNA sequences, or response elements, as well as with molecules of various signaling pathways, or cross-talk, results in the expression of target genes. The integrated effects of these target gene products orchestrate cellular proliferation, differentiation, and death. (Fall)

595. PhD Research
Prerequisite: Credit: to be arranged.

Ph.D. research, done under the direction of a faculty member in any of the the graduate Ph.D. programs at the University of Rochester Medical Center. (Fall Spring Summer)
Pharmacology and Physiology


The objective of the graduate programs in pharmacology and physiology at the University of Rochester is to provide a thorough understanding of basic pharmacology and physiology and to prepare graduates for careers as investigative pharmacologists and physiologists. The programs include coursework in pharmacology, physiology, and the basic biomedical sciences; participation in the departmental seminar program; and original laboratory investigations in pharmacology or physiology. The PhD program can lead to either a PhD degree in pharmacology or a PhD degree in physiology. The PhD degree is awarded upon completion of scholarly work and research described in a publishable dissertation.

Students entering this program should have a four-year baccalaureate degree in the basic or applied sciences, for example, biology, chemistry, or biomedical engineering. Students with degrees in other disciplines may also apply but should have some basic training in biology, biochemistry, and organic and physical chemistry. Courses in molecular biology, statistics, and physics are recommended, but not required. Applicants are required to submit the results of the Graduate Record Examination. First-year graduate students typically enroll in required core courses in biochemistry (IND 408), cell biology (IND 409), and molecular biology and genetics (IND 410); and in courses (PHP 403, 404, and 502) that fulfill the degree requirements for the PhD programs in pharmacology or physiology. In addition, all graduate students must complete the Ethics and Professional Integrity course (IND 501), and at least 6 credit hours of electives, typically taken in the second-year.

403. Human Cell Physiology

This course is aimed at providing an introduction to the fundamental principles of modern cell physiology: the implications of cellular and molecular principles for the integrated physiological responses of intact organs and tissues, in both healthy and diseased states, will be discussed. The material will include basic concepts, principal research questions, and common methodologies - emphasis will be on a quantitative approach wherever possible. Course content will particularly focus on basic cellular physiology, including excitable cell physiology, and will emphasize intercellular interactions and responses to their tissue and organ environment. Recent literature relevant to the material will be reviewed and analyzed during the course. (Fall)

404. Principles of Pharmacology

Pharmacology is one of the vital disciplines in biomedical sciences. It employs the multidisciplinary knowledge in biochemistry, cell biology, chemistry, genetics, neuroscience, pathology, physiology, toxicology, and clinical medicine, to elucidate the mechanisms of action of drugs in treating human diseases. This course represents a collective endeavor of our faculty to the teaching of graduate and senior undergraduate students in UR. It focuses on the fundamental principles of pharmacology, neuroparmacology, cardiovascular pharmacology, and contemporary approaches to drug discovery and design. (Spring)

405. Effective Scientific Communications

This elective course is aimed at introducing the principles of scientific communication to the first- or second-year graduate student. Course content will focus on 1) developing the students’ ability to understand and critically evaluate current literature, 2) teaching students to become more effective writers, and 3) developing students’ ability to deliver coherent, engaging and focused oral presentations. Students will engage the material through practical examples and exercises.

440. Topics in Vascular Biology

447. Signal Transduction

Cellular signal transduction is one of the most widely studied topics in the biomedical sciences. Cells have multiple mechanisms for sensing the environment and converting the external signals into intracellular responses that are important for regulation of human physiology. Dysregulation of these processes can result in disease and manipulations of these pathways are the basis for many therapeutics.

491. Master’s Readings

492. Master’s Essay

495. Master’s Research

502. Pharmacology and Physiology Seminar

The colloquium is held on Thursdays at 12:30pm in the Anders Room (4-6912). Student presentations are interspersed with visiting seminar speakers. The colloquium is meant to be informal, and provides students valuable experience speaking before a mixed audience, fielding questions, obtaining constructive feedback on scientific work and presentation skills, and asking questions. It also facilitates others in the Department staying up-to-date on research in neighboring labs. All students take the class for 1 course credit.

* Primary appointment in another department
The Department of Public Health Sciences offers programs of study leading to the degrees of master of public health, master of science in clinical investigation, health services research and policy, and epidemiology and doctor of philosophy in both health services research and policy and in epidemiology. The master’s programs are designed to train current and future health professionals by developing and enhancing their planning, evaluative, research, and management skills. The doctoral programs train students to teach and conduct independent research in a specific field of study.

The MPH is 43 credit hours. It can be completed in two years of full-time study. The master of science in clinical investigation (MS-CLI) is 31 credit hours, the master of science in health research and policy (MS-HSRP) is 37 credit hours, and the master of science in epidemiology (MS-EPI) is 34 credit hours. They can be completed in one full-time or two part-time years of study. Courses include epidemiology, biostatistics, research methods, social and behavioral factors affecting health and illness, health services research, health policy, management and evaluation of health service organizations, environmental and occupational health, and SAS programming. All master’s students complete a research project in the area of public health and/or population research. The project is designed, carried out, analyzed, and written by the student under the supervision of a faculty preceptor and an advisory committee.

The doctoral program in health services research and policy is designed to produce researchers who generate knowledge used in solving health care problems. The course curriculum focuses on two main goals. First, it focuses on developing skills in the use of research methods (e.g., study design, statistics, decision analysis, risk adjustment, and cost-effectiveness analysis) and theory (e.g., economics, psychology, and systems theories) to address relevant questions. Second, it focuses on providing an extensive knowledge-base in substantive areas related to the institutions, structures, and functioning of the U.S. health care system. The dissertation process focuses on producing careful scientific thinkers who can integrate these skills and knowledge to identify and address vital research questions, and who can create and test theory-based policy and clinically relevant explanations of important health care phenomena.

The doctoral program in epidemiology is designed to foster scholarly achievement in the area of disease prevention and health promotion through the conduct of independent community and population research. The formal curriculum emphasizes the sequential process of reasoning that is inherent in epidemiology, while encouraging the integration of multiple disciplines in health investigations that span the biopsychosocial continuum. Graduates will have mastered a unique set of methodologic and analytic skills necessary for the practice of preventive medicine and the formulation of public health practice. Currently, there is a significant demand for epidemiologists interested in research and education to assume positions in public health organizations, universities, government, and industry.

Certificate Programs

Analytic Epidemiology
The advanced certificate in analytic epidemiology is designed to provide individuals with the knowledge and tools to assess and understand health-related information as encountered in their professional or personal lives.

Biomedical Data Science
The advanced certificate in biomedical data science prepares researchers to conduct insightful, applied “big data” analytics for health services, clinical, and public health research.

Clinical/Medical Technology
The advanced certificate in clinical/medical technology program prepares students for professional careers in clinical laboratory science. Students will complete both didactic and clinical experiences (preceptorships) at the University of Rochester Medical Center. Instructors include NYS licensed Clinical Laboratory Technologists and clinical faculty from the Department of Pathology and Laboratory Medicine.

Clinical Research Methods
The advanced certificate in clinical research methods is designed to provide researchers and other interested individuals with a practical understanding of quantitative research methods.

Health Services Research
The advanced certificate in health services research is designed to give individuals the knowledge and tools needed to evaluate the effectiveness of health services programs and policies.

Public Health
The advanced certificate in public health is designed to provide individuals with knowledge and understanding of the key elements of public health practice.

Regulatory Science
The advanced certificate in regulatory science is a multidisciplinary, cross-departmental graduate credential administered by the Department of Public Health Sciences (PHS) designed to produce a cadre of highly trained professionals able to contribute to the development of new medical interventions by enhancing the innovation, efficiency, and quality of the medical product development pipeline.
**Trial-Based Clinical Research**
The advanced certificate in trial-based clinical research is designed to give individuals the knowledge and tools needed to conduct clinical research trials.

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The Department of Public Health Sciences is housed on the third floor of the Saunders Research Building.

**PREVENTIVE MEDICINE (PM)**

**400. Data Science Practicum**
Practicum provides a practical experience for graduate students to participate in a lab, research group, or center at the University of Rochester or one of its partners on a biomedical research topic involving data science. The experience will integrate practical, field-based methods and will include participants in a team science environment. Students can expect to apply their classroom learning during the two-semester (fall and spring semesters) practicum experience. Students work in teams on pre-approve projects and meet weekly with their mentor to review progress and plans. Students will present the results of their work at the end of the spring semester. (Fall Spring)

**401. Quant Methods in Public Health Research**
Prerequisite: No audits

The purpose of this course is to familiarize students with many of the standard statistical techniques utilized in the health sciences. By the end of the course, students should be able to understand, interpret, and communicate about statistical topics including but not limited to: descriptive statistics; displaying data in tables and figures; types of data and distributions; sampling distributions and hypothesis testing; comparing means; correlation and regression; and contingency tables and sensitivity/specificity. (Fall Summer)

**402. Human Biology and Health Research**

This course aims to introduce graduate students in health research disciplines to human biology, with a particular focus on systems, disease, treatment, and etiology. The course is oriented for students with little or no undergraduate training in human biology or a clinical field, and focuses upon broad concepts of human biology. Examples from published health research are used in the course to underscore the importance of human biology in addressing questions in health services research, biomedical informatics, epidemiology, and public health. (Summer)

**403. Research Team Science Seminar**

This course introduces graduate students to the concepts, practice, and challenges of Team Science and collaborative research environments. Students will be exposed to team science (TS) initiatives and the science of team science (SciTS) as presented through practical examples from local research teams and researchers, focusing upon the practical implications of a team science approach to biomedical research requiring large-scale data analysis. (Summer)

**407. Birth & Death I: Biv Ev Perliv**
How do human beings experience, make sense of, cope with, and shape birth illness, and death in their own lives and in the lives of those who are close to them? Historical and contemporary examples from North America, Latin America, Europe, the Middle East, Africa, and Asia. (Fall)

**410. Intro to Data Management/Analysis**
Prerequisites: To enroll students must have (i) a working knowledge of Microsoft Windows and (ii) be familiar with basic statistical concepts. No Audits

This course provides an introduction to the SAS analytic software for Windows and a basic understanding of data management using MS Access, MS Excel and SAS. Through a mixture of lectures and applied lab sessions, students gain experience using MS Access, MS Excel for the management and analysis of public health data. Building on linkages to the department’s biostatistics and epidemiology curriculum, this course emphasizes the integration of data management and analysis into the research environment and the development of statistical computing skills. (Fall Summer)

**411. Health Care for the Elderly**

The aging of the US population and the projected growth of the “oldest old” will have a major impact on the demand for and the supply of services and resources needed to care for this population. Already today, older Americans with serious and disabling chronic conditions are the largest, highest-cost, and fastest-growing consumer group. What are the needs of this growing demographic? How is the US health care system responding to those needs? What kinds of services are available, how are they managed and are they sufficient? Who provides the care? How much do those services cost? Who pays for what? What about quality of care? These and other issues important to the financing and the organization of health services for older Americans are examined in the course of this 3-credit seminar (Spring)

**412. Survey Research**
Prerequisite: PM 415 Principles of Epidemiology or permission of the instructor No Audits

This course presents the necessary elements of survey instrument development and survey research methods, with a focus on practical applications in health care research, epidemiology and social & behavioral science. The integrated perspective includes a qualitative approach to survey development and interpretation and practical methods for conducting valid and reliable
survey research. Students participate in all stages of the survey research process through application of homework assignments, survey development and research project design. Grades will be determined through quizzes, participation, and a group survey project. Prerequisite: PM 415 Principles of Epidemiology or permission of the instructor. (Fall)

412W. Survey Research

413. Field Epidemiology
Prerequisite: Introduction to Epidemiology or permission of the instructor. No Audits

This course will provide an overview of the practical applications of theoretical epidemiological concepts in the study of the distribution of diseases and their causes in populations. Emphasis will be on the hands-on discussion of basic methods in epidemiologic research, including literature review; study design selection; measurement of disease; selection of relevant variables; development and administration of questionnaires; quantitative data analysis; and reporting study findings. These concepts are discussed in the context of case studies and special topics such as outbreak investigations, cancer cluster investigations, and meta-analysis. Prerequisite: PM 415 Principles of Epidemiology or permission of the instructor (Spring)

413W. Field Epidemiology

This course will provide an overview of the practical applications of theoretical epidemiological concepts in the study of the distribution of diseases and their causes in populations. Emphasis will be on the hands-on discussion of basic methods in epidemiologic research, including literature review; study design selection; measurement of disease; selection of relevant variables; development and administration of questionnaires; quantitative data analysis; and reporting study findings. These concepts are discussed in the context of case studies and special topics such as outbreak investigations, cancer cluster investigations, and meta-analysis. Prerequisite: PM 415 Principles of Epidemiology or permission of the instructor (Spring)

414. History of Epidemiology
Prerequisite: No Audits

The overall objective of this course is to focus the attention and raise the awareness of students on the historical perspectives of epidemiology. The course will familiarize the student with the growth of epidemiology, as a basic science, and show the inter-relationship between epidemiologic methods and intellectual, social, political and technological progress that has occurred throughout history. All of these events are crucial to a deeper understanding how diseases have influenced history and what major contributions epidemiologists have made to medicine. This course will explore the relationship between epidemiology and other scientific disciplines by demonstrating the influence of methodologic techniques used by epidemiologists. Additionally, the framework of this course will foster an appreciation for the role of epidemiology in society through its impact on public health from its roots to its dynamic responsibilities in present trends. (Spring)

414W. History of Epidemiology
Prerequisite: No Audits allowed

The overall objective of this course is to focus the attention and raise the awareness of students on the historical perspectives of epidemiology. The course will familiarize the student with the growth of epidemiology, as a basic science, and show the inter-relationship between epidemiologic methods and intellectual, social, political and technological progress that has occurred throughout history. All of these events are crucial to a deeper understanding how diseases have influenced history and what major contributions epidemiologists have made to medicine. This course will emphasize the relationship between epidemiology and other scientific disciplines by demonstrating the influence of methodologic techniques used by epidemiologists. Additionally, the framework of this course will foster an appreciation for the role of epidemiology in society through its impact on public health from its roots to its dynamic responsibilities in present trends. (Fall)

415. Principles of Epidemiology
Prerequisite: PH103 for undergraduate students No audits

PM 415 is intended to provide an overview of concepts dealing with the study of the distribution and determinants of health conditions in populations. We will define epidemiologic terms, introduce methods to describe health conditions in populations, provide an overview of ways to determine the causes of disease, and apply epidemiologic principles to the evaluation of preventive and therapeutic interventions. This will be carried out by online modules, lecture presentations, and small group discussions. (Fall)

416. Epidemiologic Methods
Prerequisites: PM 415, PM 410 and one semester of graduate level statistics No audits

This course provides an in-depth coverage of the Theoretical and quantitative methodologic issues associated with epidemiologic research. Issues specific to study design, conduct, and analysis are emphasized. Topics to be covered include: Issues in study design, topics in measurement, methods of data collection, confounding, bias, random error, effect modification, and multivariate analytic techniques. (Spring)

417. Molecular Epidemiology
Prerequisite: PM 415 Principles of Epidemiology No audits allowed

Using the same paradigm as traditional epidemiology, this course will explore the opportunities for the use for increasingly powerful biologic markers of exposure, disease, or susceptibility to provide high resolution answers in relation to the causes of disease. The course will focus on the practice of molecular epidemiology, as an interdisciplinary science, and the use of biologic markers to advance our knowledge about health and disease among groups of people in a manner that is appropriate for inference to larger populations.
418. Cardiovascular Disease Epidemiology and Prevention
Prerequisite: PM103 or PM415 Principles of Epidemiology No audits

At the completion of the course, students will be able to demonstrate their knowledge of cardiovascular disease epidemiology and prevention by listing and/or discussing the proven risk factors for cardiovascular disease (CVD) and the seminal studies leading to their discovery. Other important topics students should be able to describe are the emerging risk factors for CHD, strategies and interventions for preventing CHD, and the difference between risk markers and risk factors. Students should also be able to demonstrate an ability to identify and verify that a risk marker is truly independent, recognize the known and suspected risk factors for stroke and the current controversies in CVD epidemiology and prevention and how they have arisen. (Fall)

418W. Cardiovascular Epi
Prerequisite: PM103 (the undergrad course) or PM415 Principles of Epidemiology

At the completion of the course, students will be able to demonstrate their knowledge of cardiovascular disease epidemiology and prevention by listing and/or discussing the proven risk factors for cardiovascular disease (CVD) and the seminal studies leading to their discovery. Other important topics students should be able to describe are the emerging risk factors for CHD, strategies and interventions for preventing CHD, and the difference between risk markers and risk factors. Students should also be able to demonstrate an ability to identify and verify that a risk marker is truly independent, recognize the known and suspected risk factors for stroke and the current controversies in CVD epidemiology and prevention and how they have arisen. (Fall)

419. Recruitment and Retention of Human Subjects in Clinical Research
Prerequisite: No audits allowed

Recruitment and retention of research subjects typically focuses on determining eligibility, minimizing risk to research subjects and designing protocols that are not overly burdensome for the respondent/subject/community. While these concerns are important, successful and sustainable recruitment and retention extends well beyond protocol design. This course focuses on models, strategies and tactics to effectively recruit and retain human subjects, in general and specific subgroups (e.g., women, minorities, vulnerable populations). Participants will critique and design methods through the lens of an ‘emic’ (insider) and an ‘etic’ (or outsider) perspective. (Fall)

420. American Health Policy and Politics
Prerequisite: No audits allowed

This course examines the formation and evolution of American health policy from a political and historical perspective. Concentrating primarily on developments from 1932 to the present, the focus of readings and seminar discussions will be political forces and institutions and historical and cultural contexts. Among the topics covered are efforts to rationalize and regionalize health care institutions, periodic campaigns for national health insurance, the creation of Medicare and Medicaid and the further evolution of these programs, the rise to dominance of economists and economic analysis in the shaping of health policy, incremental and state-based vs. universal and federal initiatives, the formation and failure of the Clinton administration’s health reform agenda, and attempts to achieve substantial national health reform during the Obama administration. The course is in seminar format and will expect active, well-prepared student participation. (Fall)

421. United States Health Care System: Financing, Delivery, Performance
Prerequisite: No audits allowed

In this course, we examine the organization, financing, delivery, and performance of the US health care system. The inherent tradeoffs between access to care, cost, quality, and outcomes are considered from the perspective of the main actors in the system, i.e. patients, providers (physicians, hospitals, etc), health plans, insurers and payers. Topics include: need and access to care; health care insurance and financing; Medicare and Medicaid; managed care; service delivery; long-term care; public health; quality of care, and others. The aim of the course is to help students deepen their understanding of the health care system, strengthen their ability to synthesize the literature and assess key current policy issues, and to further develop their critical thinking skills. (Fall)

422. Quality of Care and Risk Adjustment
Prerequisite: No audits allowed

The purpose of this course is to explore the various methods and opportunities available to track and assess outcomes of clinical practices and medical technologies. The material covered will introduce the framework, analytic approaches, databases and settings available for studies addressing patient health outcomes and satisfaction, practice patterns, clinical interventions and strategies that constitute the content of health care. The course focuses on the use of patient populations and databases as laboratories for the generation of new knowledge and information. (Fall)

424. Epidemiology and Prevention of Chronic Disease
Prerequisite: Concepts of Epidemiology (PH 103) or Principles of Epidemiology (PM 415) No audits

This course offers an overview of the epidemiology of selected chronic diseases (cardiovascular diseases, cancer, chronic respiratory diseases, and chronic neurological conditions) and the methods to study them. By the end of the course, students should have sufficient understanding of the pathology, diagnostic classification, screening, risk factors and treatment of these diseases as well as approaches for conducting research which involves them. (Spring)
**424W. Epidemiology and Prevention of Chronic Disease**  
*Prerequisite: Concepts of Epidemiology (PH 103) or Principles of Epidemiology (PM 415) No audits*

This course offers an overview of the epidemiology of selected chronic diseases (cardiovascular diseases, cancer, chronic respiratory diseases, and chronic neurological conditions) and the methods to study them. By the end of the course, students should have sufficient understanding of the pathology, diagnostic classification, screening, risk factors and treatment of these diseases as well as approaches for conducting research which involves them (Spring)

**425. Health Promotion and Preventive Medicine**  
*Prerequisite: No audits*

This course will provide the learner with a solid foundation and appreciation for primordial, primary, secondary, and tertiary disease prevention strategies on both an individual (patient and provider) and population-wide basis (society as a whole). The overarching theme of the course is to impress upon the learner the importance and need for preventive health behavioral interventions and the positive impact healthy behavior change can have on our society as a whole on an environmental, economical, and social level. (Spring)

**426. Social and Behavioral Medicine**  
*Prerequisite: No audits*

The overall goal is to examine the public health impact of behavioral, psychosocial, cultural, and environmental factors on the development, prevention, and treatment of health problems. This is a survey course designed to introduce students to a wide range of social and behavioral determinants of health, health behavior change, and health disparities over the life course. (Spring)

**427. Neurodevelopmental and Related Disorders**

This course provides a conceptual framework for development of leadership in the field of neurodevelopmental disabilities. Students are guided in correlating their own personal characteristics with their leadership type. The environment in which services for individuals with neurodevelopmental disabilities are provided is examined including legislative influences, fiscal constraints, service models, and societal values (Fall)

**428. Health Services Research Seminar**  
*Prerequisite: No audits*

A one-credit course required of all Health Services Research doctoral and students. A variety of topics will be presented for discussion. (Fall Spring)

**430. Psychology in Health Services Research**  
*Prerequisite: HSR doctoral student or permission of instructor no audits*

As health services research moves from descriptive to explanatory work for informing policies and interventions, the use of theory becomes essential. Psychology provides theories for explaining individual and social behavior that can underlie many phenomena of interest. For example, psychological theories have been used to understand patient and physician communication and decision making, medical errors, healthcare disparities, and patient engagement of preventive care or persistence with treatment regimens. This course has two objectives: (1) to introduce students to basic and health-related psychological and social-psychological theories germane to health services research, and (2) to introduce the process of creating theory-based explanations (Fall)

**431. Advanced Methods in Health Services Research**  
*Prerequisite: HSR doctoral student or permission of Instructor*

The purpose of this course is to provide students with a strong understanding of, and experience in, advanced quantitative methods for health services research. Topics covered will be longitudinal models (e.g. fixed and random effects, conditional, marginal and structural models), causal inference (e.g. difference-in-differences, propensity score methods, instrumental variables, regression discontinuity, and quantile/nonlinear regression), and practical considerations for handling data (e.g. missing data, data structures, effective programming). Time permitting, we will also cover spatial methods and some topics in “Big Data”. The course will be taught by lecture and hands-on sessions. The emphasis of the course will be on applications that will be useful for students to implement in their thesis work. (Fall)

**436. Molecular Spectroscopy & Str**

**438. Grantmanship**  
*Prerequisite: no audits*

The Miriam Webster dictionary defines the term grantmanship as “the art of obtaining grants”. This definition accurately identifies the process of successfully obtaining grants as an art form requiring skill and judgment to be successful. The purpose of this course is to help learners develop this skill-set. Major topics will include a review of funding opportunities and how to find them, how to prioritize potential grant opportunities, how to develop a research idea and project proposal into a grant application, and how to approach completing the actual grant application process. This will be a moderated online course. All course materials and interactions with instructors and fellow students will be conducted online. Instructors will be available on a regular basis to answer questions and review submitted work. (Fall Spring Summer)

**442. Nutritional Epidemiology**  
*Prerequisite: no audits*

This is a methods course. We will cover the assessment of dietary intake and nutritional status as exposure and/or outcome measures and we will apply the concepts of nutritional epidemiology to nutritional-related conditions of public health relevance (Spring)
442W. Nutritional Epidemiology
This is a methods course. We will cover the assessment of dietary intake and nutritional status as exposure and/or outcome measures and we will apply the concepts of nutritional epidemiology to nutritional-related conditions of public health relevance.

443. Foundations of Maternal and Child Health
Prerequisite: no audits
This course is designed to provide students with an overview of major health issues through the life course of women and children and public health responses to these issues in the U.S. and in low-income countries. The course introduces students to the field of maternal and child health from its historical development, current health priority issues, barriers to care, and public health interventions. (Fall)

445. Introduction to Health Services Research
Prerequisite: no audits
The Institute of Medicine defines health services research (HSR) as “...a multidisciplinary field, both basic and applied, that examines the use, costs, quality, accessibility, delivery, organization, financing, and outcomes of health care services to increase knowledge and understanding of the structure, process, and effects of health services for individuals and populations.” This course will provide a hands-on introduction to the field of health services and policy research and introduce students to a variety of tools useful in conducting health services research and using HSR findings. We will use a hybrid model with instruction and learning activities divided across weekly face-to-face meetings (except for 2 weeks as noted in the course schedule) and online activities. (Fall)

448. Health Policy
Prerequisite: No audits
This course provides an introduction to policy analysis in the context of public health and health care. The course focuses on developing the logic and argumentative skills necessary to produce compelling analyses of existing and proposed policies. Special attention will be given to the implementation of the PPACA reform legislation. (Spring)

449. Writing Workshop

450. Master of Public Health Practicum
The intent of this practicum is to engage students in activities aligned with their career goals, as well as activities that demonstrate application of public health science concepts and critical thinking relevant to the student’s area of interest within community organizational settings. Students will partner with a community agency to conduct evidence-based activities that meet a programmatic goal of the partnering agency addressing population-health issues. These activities will further develop the student’s skill set in program design, implementation and/or evaluation. Upon completion of the program, students will be able to provide evidence of application of these skills to potential employers. Students will work independently with a faculty supervisor to create and outline an appropriate plan for an onsite practicum experience (Fall Spring Summer)

451. Epidemiology of Infectious Disease
Prerequisite: No audits
This course will review the epidemiology of infectious diseases of national and international importance, including acute respiratory infections, diarrheal diseases, hepatitis, HIV, tuberculosis, influenza, sexually transmitted diseases, parasitic diseases, vector-borne diseases, vaccine preventable diseases, and antibiotic resistance. Students will learn how to assess the public health implications of specific pathogens in the United States and worldwide. Emphasis will be on epidemiologic methods for disease surveillance, outbreak investigations, case-control studies, cohort studies, molecular epidemiology, dynamics of transmission, impact of host immunity, and assessment of various control methods including vaccinations. (Fall)

451W. Epidemiology of Infectious Disease
Prerequisite: No audits
This course examines the epidemiology of infectious diseases within a biological and methodological framework. Students will be introduced to the objectives of conducting research in infectious diseases and the methodologies used to accomplish these objectives. There will be a particular focus on topics not applicable to the study of chronic diseases, such as vaccination, immunity, and transmission dynamics. Students will also gain an appreciation for the public health importance of specific pathogens in the United States and globally.

452. Comm Health Improvement Practicum
Prerequisite: No audits
This practicum course educates students in the appropriate knowledge, attitudes, and skills necessary for developing population-based interventions, and understanding the connection between community and health. The main goal is to facilitate key partnerships for sustainable interventions (group projects) in the community to improve health at the population level. (Spring)

456. Health Economics I: Introduction to Health Economics
Prerequisite: HSR doctoral student or permission of instructor
This is an introductory course that will cover the basic principles of economics and their variations used to understand the production of health, the supply and demand for medical care and health insurance, and market competition in medical care, including the markets for health insurance, medical services, hospital services, pharmaceuticals, medical education, physicians, and nurses. The course will use graphs and calculus-based mathematical models to communicate main concepts and principles (Fall)

458. Qualitative Health Care Research
Prerequisite: NO AUDITS
A community’s health is not just determined by individual health behaviors, but also by cultural beliefs and forms of social organization. Traditional quantitative methodologies, which
have been so powerful in understanding biological phenomena, have limited explanatory power in analyzing socio-cultural phenomena. Qualitative methods, long used in the social sciences, allow for the collection, analysis, and interpretation of social and cultural data that quantitative methods cannot adequately reach. In addition, qualitative methods can function as an essential adjunct to quantitative methods by hypothesis generation or identifying lay terminology for accurate survey developed. This course will cover standard qualitative methodologies through a discussion of relevant literature, class exercises, and a class project. (Spring)

460. Master’s Essay
This research project is designed, carried out, analyzed, and written up by the student under the supervision of, and in consultation with, an essay advisor and an advisory committee. (Fall Spring Summer Winter)

461. Program Evaluation in Public Health
Prerequisite: No Audits
Provide MPH students with practical skills to organize and conduct credible and useful evaluations of health or human service projects or programs. Focusing on methods, this course will help students design and critique approaches to answer two key questions central to program evaluation: Is this program working as intended? Why is this the case? Students will learn the theories behind program evaluation and how to prevent or overcome common evaluation planning and implementation challenges and pitfalls. Students will also develop additional skills in designing programs, writing objectives, working with stakeholders, establishing appropriate measures/data gathering tools, designing implementation specifications, analyzing results and presenting findings. (Summer)

462. Laboratory Methods for Translational Research
Prerequisite: No Audits
Objectives: A number of different laboratory methods are needed for the various facets of translational research: discovery of pathways involved in diseases, development of screens for molecules that can target these pathways, biomarker discovery, and even more routine patient screening and outcome measures. This course will explain the basis of commonly-used laboratory technologies, including genomics, proteomics, transgenic mouse models, basic molecular biology methods, cell sorting, chromatography, etc. Both lectures and discussions of the primary literature will be used to survey these methods. The goal is for the students to have a basic understanding of a broad range of methods (both advantages and pitfalls), not to learn detailed protocols for any particular technology. (Fall)

463. Introduction to Mathematical Statistics: Part I
Prerequisite: HSR doctoral student or permission of instructor
The goal of this course is to familiarize students with basic elements of probability and mathematical statistics. At the completion of this course the student will be familiar with set theory and notation, understand probability theory, be familiar with special distributions, both discrete and continuous, understand how to approach functions of random variables, and understand limit theorems in statistics. (Fall)

464. Introduction to Regression Analysis
Prerequisite: PM 463 or permission of instructor. No Audits
The course will focus on the ordinary least squares regression, including the theory, assumptions as well as the necessary alterations required to conduct valid analysis when those assumptions are not met. The course will also cover other commonly used regression models (e.g., logistic regression). The course will provide students with analytic skills to test model assumptions, perform hypothesis testing, and interpret model parameters. (Spring)

465. Advanced Methods in Health Services Research II
Prerequisite: HSR doctoral student or permission of instructor
The first part of this course introduces general estimation frameworks including least squares (specifically, least squares as applied to multivariate models, and nonlinear least squares), maximum likelihood, generalized method of moments, generalized linear models and generalized estimating equations, and some corresponding variants (e.g., quasi-likelihood, Monte Carlo methods, and instrumental variables). The second part of the course focuses on the application of the preceding estimation methods to the development and analysis of qualitative and limited dependent variable models (e.g., logit, probit, multinomial/conditional/nested logit, multinomial probit, mixed logit and probit, and censored and truncated data), duration models (e.g., Kaplan-Meier product limit estimator, Cox’s proportional hazard model, and full parametric specifications), and multivariate models (e.g., multivariate regression, sample selection models, and simultaneous equation models). (Spring)

466. Cancer Epidemiology
Prerequisite: No audits
The purpose of this course is to provide the student with a basic understanding of the biology, burden, epidemiology, natural course, treatment and complications of malignancies in the United States and the etiologic factors associated with each of the most common cancers. The course will include discussion of patterns of cancer incidence, molecular, genetic and environmental aspects of etiologic factors, risk assessment using biomarkers and other screening tools, stages of neoplastic development and interventional approaches related to prevention, screening and treatment. Didactic material will be presented on each topic and selected papers from the literature will be reviewed and discussed. (Fall)

469. Multivariate Models for Epidemiology
Prerequisites: PM416 Epidemiological Methods, knowledge of SAS or other statistical software, or permission of the instructor. No audits
The purpose of this course is to provide students with a strong understanding of, and experience in, advanced quantitative methods for the analysis of epidemiologic studies. Coverage
includes analytic issues (e.g., confounding and interaction) within a broad survey of important methods for multivariable analysis of epidemiologic data. Though some lectures may include somewhat technical material, the general approach and emphasis of the class is applied (Fall).

470. Environmental & Occupational Epidemiology
Prerequisite: PM 415 or equivalent no audits
This is an intermediate-level course designed to familiarize students with the conduct of environmental and occupational epidemiology studies. Students will become familiar with specific environmental and occupational research areas, as well as the unique epidemiologic or exposure methodologies used in those studies. This is not a survey course of broad content areas. The focus will be on the application and interpretation of epidemiologic methods and findings in environmental and occupational health. Students will be asked to analyze, evaluate, summarize, and present published studies used to investigate health effects related to environmental and occupational exposures. (Fall)

470W. Env & Occ Epidemiology

472. Measurement & Eval of Res Instruments
Prerequisite: PM 415 OR PHS 103 no audits
The purpose of this course is to provide the student with a comprehensive background in the development and testing of self-report instruments for epidemiologic research purposes. A review of the principles of survey development will begin the course, however, it will rapidly move to a more hands-on approach as students will learn how to run and interpret classical test theory analyses, factor analyses, responsiveness to change analyses and Item Response Theory (IRT) analyses of item pool data. The students will learn how to use and integrate these statistical approaches to develop self-report instruments with high levels of validity and low levels of measurement error (Spring).

476. Ctsi Seminar Series
A weekly seminar series for Clinical Translational Research Curriculum participants. This series will include presentations from UR training mentors, guest lecturers, experts in technological innovations in clinical research, as well as trainee presentations. (Fall Spring)

477. Advanced Sas
The purpose of this course is to provide students with advanced knowledge and experience in SAS programming for the management and analysis of data in epidemiological studies. This course is an extension of PM 410 Introduction to Data Management and Data Analysis Using SAS and is not recommended for beginning SAS software users. The topics include descriptive statistics, basics of macro writing and the output delivery system (ODS), sample size calculations, ANOVA, survival analysis using Kaplan-Meier techniques, and multivariable regression techniques (linear, logistic and Cox regression). Furthermore, this course will provide an overview of building forms and databases using Microsoft Access and Epi Info. Finally, students will be given an introduction to other statistical software packages and compare their utility to SAS. Prerequisites: PM 410 and one semester of graduate level statistics, or permission of the Instructor. (Fall)

478. Workshop in Scientific Comm
Prerequisite: No Audits
A 1-credit course required of all Rochester Clinical Research Curriculum trainees; open to trainees in other programs. This workshop addresses: scientific writing; abstract preparation; poster creation and presentation; oral presentation dos and don’ts; responding to manuscript reviews and critiques; performing manuscript reviews; Word, PowerPoint, Excel, Endnote software tips for manuscript formatting; copyright issues; and administrative sections of grant applications (proper Biosketches; Support letters from Collaborators; Resources and Environment; Resource Sharing, Biohazard or Select Agent plans; Training in the Responsible Conduct of Research). Each student will be required to complete one writing/presentation assignment during the semester (scientific manuscript, review article, poster presentation, an abstract and oral presentation, or sections of a grant proposal). This is an excellent opportunity for those taking Practical Skills in Grant Writing (PM 438) to improve grant writing skills. (Spring)

479. Health, Medicine and Social Reform
Prerequisite: No audits
Examination of the interconnected histories of medical science, public health, and political action promoting social and health reform, from the Scientific Revolution of the seventeenth century to the present. Attention will also be directed to improvements in health status, variations in the distribution of disease and risk, and changes in the social role of medicine and medical institutions. The course material includes both major primary sources (Frank, Engels, Virchow, Riis, Hamilton, and Geiger) and secondary analyses (by Rosen, Navarro, Starr, Jones, and Brown) (Fall)

480. Changing Concepts of Health and Illness
Prerequisite: No audits
Examination of the interconnected histories of medical science, public health, and political action promoting social and health reform, from the Scientific Revolution of the seventeenth century to the present. Attention will also be directed to improvements in health status, variations in the distribution of disease and risk, and changes in the social role of medicine and medical institutions. The course material includes both major primary sources (Frank, Chadwick, Engels, Virchow, Riis, and Geiger) and secondary analyses (by Rosen, McKeown, Navarro, Starr, Jones, and Brown) (Spring)

483. Advanced Health Economics II
Prerequisites: Microeconomics (ECO 207 or ECO 471), Health Economics I and calculus.
Comprehensive course covering micro-economic theory and its application to health and health care markets. Topics include consumer decision making, the theory of the firm, market
imperfections, and human capital formation. Applications in health economics include the demand for health, determinants of health, rational addiction, how consumers respond to information about health care, adverse selection in health insurance, and the moral hazard created by physician compensation strategies. Each student writes a research sketch, testing predictions from microeconomic theory and defining the appropriate econometric model as a final project. Prerequisites: Health Economics I and calculus (Spring).

484. Med Decisions and Cost Effect Research
Prerequisite: At least one semester of graduate level statistics. No audits
Decision and cost-effectiveness analyses are increasingly used to evaluate alternative choices in clinical practice and to enlighten and inform health policy determinations. In this course, students are introduced to the methods and objectives of decision analysis and cost-effectiveness research, as well as to important study design issues that distinguish these investigations from other clinical research studies. Students will also learn decision analysis software such that they can perform analyses themselves as a class project. After completion of the course students will: a) understand the concepts underlying decision analytic methods and how to apply them to help decision makers make better clinical and policy decisions; b) know how to structure decision problems using decision trees, influence diagrams and multi-attribute value trees; and c) know how to conduct single and multiple outcome decision analyses, including cost-effectiveness analysis. (Spring)

485. Intro to Biomed Informatics

486. Med Ecology in Global Context
Prerequisite: no audits
This course will explore environmental health issues from both a local and global perspective and will offer students a comprehensive introduction to environmental health. We will survey the major issues in contemporary environmental health, ranging from global issues such as climate change and war to regional issues such as air, water, transportation, and energy to local issues such as food safety, pest control, and occupational health. The course focuses on the real-world practice of environmental public health. (Fall)

487. Fundamentals of Science, Technology & HP
Prerequisite: no audits
Science and Technology (S & T) continues to be an area of significant focus to drive innovation, improve public health and enhance national security in the U.S. and across the globe. This interactive course will offer students exposure to the interaction between S & T and public policy, particularly exploring the role and impact of the Federal government in this process. Students will also have the opportunity to explore roles for scientists in the policy making process, while gaining the ability to objectively analyze S & T policy issues and develop skills to provide policy recommendations and write policy memos. Some assignments will be tailored to individual students’ policy interests and may be reviewed by the course instructor as well as consultants directly familiar with the issue. Note: This class is broadly designed for students both in the basic and applied sciences interested in the S & T policy process, as well as students focused on public health related policy issues. (Spring)

488. Experimental Therapeutics
Prerequisite: no audits
This course is designed for individuals interested in the process for identifying novel interventions for diseases, and for their eventual introduction into humans. Topic areas covered will include: preclinical assessment of an intervention’s ability to modulate disease, the preclinical safety data needed before initiating human experimentation, the appropriate techniques for extrapolating dosages from animals to humans; types of human experimentation (Phase 1-Phase 3 clinical trials), the level of animal and human evidence necessary to progress from one phase of experimentation to the next, and the ethical underpinnings of human experimentation. (Including CTSI Skill-Building Workshop Series Seminar: Good Advice: Case Studies in Clinical Research, Regulation, and the Law). (Fall)

489. Injury Epidemiology and Emergency Care Research Methods
Prerequisite: PH103 or PM415 or permission of instructor no audits
The course is designed to provide the student with an introduction to the fields of injury epidemiology and emergency care research. This course will provide an overview of the epidemiology of traumatic injuries and how epidemiologic methods are applied to study injury, including issues of exposure and outcome measurement, study design and analysis. Students will also be introduced to the unique challenges and opportunities when conducting research in the emergency care setting (e.g., emergency departments and ambulance-based pre hospital care) including approaches to subject recruitment, consent, and risk adjustment. (Fall)

489W. Inj Epi & Emer Care Res Mthd
Prerequisite: PH103 or PM415 or permission of instructor
The course is designed to provide the student with an introduction to the fields of injury epidemiology and emergency care research. This course will provide an overview of the epidemiology of traumatic injuries and how epidemiologic methods are applied to study injury, including issues of exposure and outcome measurement, study design and analysis. Students will also be introduced to the unique challenges and opportunities when conducting research in the emergency care setting (e.g., emergency departments and ambulance-based pre hospital care) including approaches to subject recruitment, consent, and risk adjustment. (Fall)
Toxicology

The core faculty involved in the Toxicology Graduate Training Program are drawn predominantly, but not exclusively, from the Department of Environmental Medicine and several other Medical Center departments.

Professors Cory-Slechta, Dean, Finkelstein, Georas, Johnson-Voll, Lawrence, Miller, Noble, O’Banion, O’Reilly, Phibbs, Pryhuber, Puzas, I. Rahman, Robert, Sime, Topham, van Wijngaarden, Williams
Associate Professors Benoit, DeLouise, Elder (Program Director), Faza, Majewska, Mayer-Pröschel, Pröschel, A. Rahman, Rand, Rich, Xia, Zuscik
Assistant Professor Gerber, Jusko, Susiarjo

By its nature toxicology is highly interdisciplinary. It combines the knowledge base and approaches of such fields as physiology, pharmacology, psychology, biochemistry, and molecular biology to address fundamental questions regarding the mechanistic effects of chemicals on living organisms.

Our program is among the most established and renowned research-oriented, degree-granting toxicology programs in the nation. Since 1966, graduates from the Toxicology Program at the University of Rochester have been making significant contributions to science through their positions in universities, chemical and pharmaceutical companies, government, and research institutes. It is one of a select few programs funded by the National Institute of Environmental Health Sciences (NIEHS) and is augmented by an NIEHS Environmental Health Sciences Center. The presence of this center and the strength of the associated faculty offer a unique opportunity for students to learn the theory and techniques of modern biomedical research approaches while applying them to address real and significant issues in toxicology and environmental health that expand knowledge at the molecular level, whole organism, and human population. In general, about 28 students are in residence.

The major disciplinary areas within toxicology at Rochester are the following. It should be recognized that there is a great deal of overlap among these categories.

Neurotoxicology. Chemicals acting on the nervous system, either directly or indirectly, are studied in many different species by a variety of techniques. For instance, recent experiments have studied indices of behavior, motor activity, discriminative control and learning, and neuroimmune interactions, as well as effects on neurotransmitters and their receptors. Nanoparticles, heavy metals, organic solvents, nerve poisons, abused drugs, and air pollutants are among the agents studied.

Cardiovascular and pulmonary toxicology. Physiological and biochemical studies of the lung and vascular system are made in order to discover how toxicants, lipid mediators, and other environmental factors influence injury, repair, and homeostasis. Mechanisms of deposition and clearance of inhaled particles are studied in both laboratory animals and humans. Cellular and molecular aspects of chronic lung injury (e.g., pulmonary fibrosis, chronic obstructive pulmonary disease, asthma) are investigated using cultured cells, animal models, and human subjects, and data are used to better predict effects in humans and, perhaps, develop protective measures and novel therapies.

Osteotoxicology. Investigations are conducted of the molecular and cellular biology of the skeletal system and its development. Ongoing research includes studies to understand the cellular and molecular mechanisms by which exposure to various pollutants, lipid mediators, and novel therapeutic agents modify critical processes within bone development and regeneration.

Molecular modifiers of toxicity. Studying the molecular mechanisms via which chemical agents modify cellular processes forms the foundation of research in many toxicology program labs. Projects include cell surface and intracellular receptor-mediated modulation of gene expression, signaling cascades, and cellular function by a variety of environmental agents. Detailed molecular analyses and hypothesis testing are combined with state-of-the-art gene expression profiling, proteomic and metabolomics approaches to identify novel molecular targets.

Immunotoxicology. The immune system is critical for controlling host defense against pathogens and detecting and destroying cancer cells. Poorly controlled immune function underlies numerous chronic diseases. Research includes the study of how various exposures alter host responses to infection, leukocyte development, and the regulation of antibody-producing lymphocytes by prostaglandins. Other research examines how exogenous factors, including oxygen and other inhaled agents, aryl hydrocarbon receptor ligands and lipid mediators of inflammation contribute to the ontogeny or severity of immune-mediated diseases such as asthma and autoimmune diseases.

Reproductive and Developmental Toxicology. It is now appreciated that early life exposures (in utero or shortly after birth) have a profound impact on a broad range of diseases, and that the detrimental action of these exposures is often not appreciated for many years. Research in this area focuses on a range of problems associated with developmental immunology, nervous system and pulmonary development, metabolism and obesity, and placental function. A particular interest has been establishing the mechanisms of action for metals, pesticides, oxygen, and other inhaled agents, aryl hydrocarbon receptor ligands, lipid mediators of inflammation, retinoids, steroids, and drugs used for the treatment of HIV infection during reproduction and development.

Stem cells and epigenetics. There is also growing appreciation that environment cues have a fundamental effect on aspects of stem cell biology and epigenetic regulatory mechanisms. Research in this area overlaps with the six research areas described above; however, it also reflects a unique subset of projects that include chromatin remodeling, DNA methylation, histone methylation, and the relationship between altered epigenetic profiles created during development and disease susceptibility or pathology later in life. Other research focuses on specific stem cell niches, including neuronal stem and precursor populations, hematopoietic stem cells and lineage committed precursors, and mesenchymal stem cells.

The curriculum for predoctoral students provides broad exposure to biochemistry, molecular biology, physiology, pathology, pharmacology, and toxicology. While fulfilling the
program’s course requirements during the first year or so, students work on abbreviated research projects in several laboratories (“rotations”). Seminars provide students an opportunity to explore particular areas in greater depth as their interests focus upon specialized research problems. The program is flexible, and seminars and special topics courses are organized on an ad hoc basis when there is a need to explore an area not covered in regular offerings and to keep abreast of the most cutting-edge advancements in the field. After the first two years almost all of the students’ time is devoted to laboratory research. Graduate study in the program is intended for students pursuing the PhD.

**521. Toxicology I—Biochemical Toxicology**

This course covers the principles of toxicology and their applications with emphasis on understanding fundamental mechanisms of toxicant-target interactions at the molecular and cellular levels. Topics covered include toxicokinetics, biotransformation, transport and elimination, receptor theory and endocrine disruption, oxidative mechanisms and reactive intermediates, genotoxicity, carcinogenesis and epigenetic modifications. These concepts will be related to understanding human health consequences of toxicant exposures in relevant tissue and organ systems. Practical application of these concepts will be introduced through examples of exposure assessment studies and environmental epidemiology. (Spring)

**522. Toxicology II—Organ Toxicology**

This course focuses on determinants of toxicity in the major organ systems of the human body and in the developing organism. Introductory material will be presented within each lecture block regarding the basic structure and purpose of the organ systems as these relate to specific examples of toxicological responses. (Fall)

**530. Developmental Toxicology**

This course emphasizes the problems associated with infertility, embryonic development, maternal physiology, and postnatal growth following exposure to environmental and the therapeutic agents. (Spring, even years)

**533. Neurotoxicology**

This course focuses on determinants of toxicity in the central nervous system. By the end of this course, you will have a deeper understanding of the basic principles and mechanisms of toxicity that are specific to the central and peripheral nervous system. (Spring, even years)

**558. Toxicology Seminar**

Seminars by students examine critically the published research on selected problems in toxicology. Required of all toxicology doctoral candidates. (Spring)

**564. Pulmonary Toxicology**

A specialty seminar that requires presentations from recent literature considering the effects of lung-directed toxic agents on pulmonary anatomy, physiology, and biochemistry. (Fall, odd years)

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**Translational Biomedical Science**

Professors Bazarian, Bennett, Calvi, Carney, Cory-Slechta, Dewhurst, Dirkson, Dorsey, Dozier, Dumyati, Dye (Co-Director), Falsey, Fiscella, Fowell, Georas, Halterman, Holloway, Huxlin, Kautz, Land, Lawrence, Lewis, Lord, Luo, Maggirwar, Mariani, Mathews, Miller, Mink, Nedergaard, O’Banion, Olchowka, Osip, Palis, Phipps, Sant, Schwarz, Smith, Strawderman, Topham, VanWijngaarden, Wedekind, Werren, Zand

Associate Professors Almudevar, Arcoleo, Benoit, Brown, Dunman, Gill, Martinez-Sobrido, McIntosh, Mohile, Morrell, Murphy, Simpson-Haidaris, Veazie, Wu

Assistant Professors Alio, Baas (Co-Director), Eliseev, Ghoshal, Hill, Jusko, Kobie, Thakar

The goal of the PhD program in Translational Biomedical Science is to prepare individuals for independent careers along the translational research spectrum with in-depth knowledge of disease mechanisms. Participants in the program will receive in-depth co-mentoring to assure skills development and productive research training. The program aims to teach fundamental theory and knowledge in subject areas including systems biology, drug design, biostatistics and computational biology, epidemiology, molecular mechanisms of diseases, laboratory methods and analytical skills, human subjects research, regulatory science, and population science essential to translational research. The program aims to provide a critical environment fostering inquiry, integrity, academic scholarship, high productivity, and skills development to excel at multidisciplinary team science.

**Curriculum**

**Core Courses**

- IND 501. Ethics and Professional Integrity in Research
- PM 415. Principles of Epidemiology
- BST 461. Introduction to Biostatistics or BST 467, Applied Biostatistics for Biomedical Science
- IND 419. Introduction to Quantitative Biology or PM 410. Intro to Data Management and Analysis
- PTH 509. Pathways to Disease I

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• PTH 510. Pathways to Disease II
• BST 465. Design of Clinical Trials
• PTH 571. Molecular Basis of Disease
• PM 486. Medical Ecology
• PM 488. Experimental Therapeutics
• Student Seminar Course

The additional core and elective coursework is highly tailored to the individual to accomplish discipline-specific research and career goal objectives while meeting the requirements for degree fulfillment. TBS students select courses from other PhD programs in the School of Medicine and Dentistry and Arts, Sciences & Engineering with guidance and approval from the TBS program director and steering committee. Additional coursework information is available at the following PhD program sites:
• Biochemistry and Molecular Biology
• Biomedical Engineering
• Biophysics, Structural, and Computational Biology
• Cellular and Molecular Pharmacology and Physiology
• Epidemiology
• Genetics, Development, and Stem Cells
• Health Services Research and Policy
• Immunology, Microbiology, and Virology
• Neuroscience (program of entry for Neuroscience and Neurobiology and Anatomy PhD programs)
• Pathways of Human Disease
• Statistics and Statistics with concentration in Bioinformatics and Computational Biology
• Toxicology

Infection and Immunity: From Molecules to Populations

The Infection and Immunity: From Molecules to Populations (IIMP) is a transformative training focus in the Translational Biomedical Science Program.

This program was selected for funding by the Burroughs Wellcome Fund and is co-directed by Nancy M. Bennett, MD, director of the Center for Community Health and co-director of the University of Rochester Clinical and Translational Science Institute (CTSI), and Stephen Dewhurst, PhD, chair of microbiology and immunology and vice dean for research at the University of Rochester School of Medicine and Dentistry.

The goal of the TBS program is to prepare individuals for academic and clinical careers relating to the translation of basic biomedical research into clinical strategies to improve health.

The mission of the IIMP training focus in TBS is to prepare the next generation of researchers who can lead interdisciplinary research combining population approaches with insights generated at the cellular and molecular level.

About the Program

Students in the IIMP training focus cross-train in both population and basic sciences of infection and immunity. From the perspective of population scientists, basic science is playing a bigger role in understanding the patterns and causality of disease and health. For example, infectious disease surveillance will soon be based on whole genome sequencing and other advanced molecular detection techniques.

Knowledge of these methods and interpretation of the data they produce will be critical to understanding the patterns and transmission of disease. Similarly, basic scientists will need to understand and demonstrate the impact of their work on the health of the population. Thus, it will be essential that they understand the language and concepts of population health.

Curriculum

Our flexible, student-centric curriculum can be tailored to individual student needs, and all trainees are overseen by dual mentors, one each from laboratory and population sciences. A number of new courses and innovative cross-training opportunities provide training in team science, research collaboration, and the soft skills important for career success. Furthermore, all trainees conduct research in population science and in laboratory science through Immersive Cross-Disciplinary Internships and Externships under the mentorship of program faculty.

The program has broad impact by promoting research on challenging contemporary questions that cross discipline boundaries at the interface of population and laboratory science, and prepares students for high impact careers as research leaders in infection and immunity.

The core curriculum for all TBS PhD students is listed above. Additionally, students following the IIMP training focus take discipline-specific courses in microbiology, immunology, and/or virology to align with the focus of their dissertation research.

The Translational Biomedical Science program office is located on the basement level of the Clinical and Translational Science Institute in the Saunders Research Building.

Clinical and Translational Science Institute
265 Crittenden Boulevard, Box 420708
Rochester, NY 14642-0708
Telephone: (585) 275-0656 or fax: (585) 276-1122
Email: jasmine_glaspy@urmc.rochester.edu
Aab Cardiovascular Research Institute

Professors Berk, Lowenstein, Miano, Yan
Associate Professors Jin, Korshunov, Morrell, White
Assistant Professors Anderson, Cameron, Pang, Small, Yao

The University of Rochester Medical Center opened the Aab Cardiovascular Research Institute (CVRI) in 2007. More than 80 scientists, students, and technicians that were housed across the Medical Center’s campus were brought together under one roof.

The 13 cardiovascular research laboratories in the institute currently conduct more than 40 research projects with the goal of furthering the understanding of heart disease. Projects range from the design of novel diagnostic approaches to research into how atherosclerotic plaque builds up in arteries to efforts to identify genes that control heart failure. Along with cardiovascular scientists, the newly renovated facility will house 13 researchers from Functional Genomics, a core facility that services researchers throughout the University and Medical Center, providing analysis of genetic material using state-of-the-art techniques.

A major component of our efforts also centers on the training of students, residents, and cardiology clinical and research fellows. By utilizing a full-time academic faculty with significant research interests and abilities and the clinical and research resources of the University and the Hospital, we are able to provide training programs that produce well-rounded clinical and research cardiologists. Our graduates are routinely sought out for top positions in both clinical and research institutions in the region and around the nation.

CARDIOVASCULAR BIOLOGY AND DISEASE

401. Cardiovascular Biology and Disease

This course is designed to provide students with a comprehensive overview of the structure and function of the cardiovascular system in both normal and pathological states. Disease processes affecting normal cardiovascular homeostasis will be discussed in the context of both human disease and experimental model systems. The course will introduce clinical/translational topics, signal transduction and current therapies of the cardiovascular system. Lecturers include both clinical and basic scientists, providing a bench-to-bedside addition to the Ph.D. curriculum. The course is comprised of lectures, paper discussions, and student presentations. A take home final exam will be given based on questions developed by each lecturer. Lectures are based on historical and recent literature. There is no required textbook. Materials and literature are provided to students on Blackboard. The course grade will be based upon class participation, an oral presentation, a written paper, and a final exam.

402. Seminar in Cardiovascular Sciences

The Cardiovascular Science seminar series features lectures by prominent cardiovascular scientists from around the world. The seminar series includes lectures by scientists whose research ranges from basic science to clinical medicine, pathobiology, genetics, and development. Between 10 and 14 outside speakers are invited from September through May each year. Students and selected postdoctoral fellows are invited to attend a luncheon with outside speakers, providing an exceptional opportunity for interaction with and exposure to the world’s leading translational cardiovascular scientists. In addition to outside speakers, the Cardiovascular Science seminar series provides a forum for URMC faculty to present their current research. Graduate students may take the course for credit. All members of the Rochester scientific community are invited to attend the lectures.

501. Clinical Clerkships Cardiology
Eastman Institute for Oral Health

Professors Bahreman, Calnon, Caton, Elad, Eliav (Chair), Ercoli, Fishman, ¹Hsu, Malmstrom, Meyerowitz, Pollan, ²Quivey (Director), Ren, Rossouw, Saunders, Tallents, Westesson
Associate Professors Ayoubi, Derosa, Gajendra, Huang, Huang, Kolokythas, Kopycka-Kedzierawski, Levy, Lipschitz, McLaren, ¹Ovitt, Psoter, Watson, Yunker
Assistant Professors Abayon, Arany, Baig, Carlson, Carranza, Chochlidakis, DeLucia Bruno, George, Gupta, Jucan, Khan, Liu, Ly-Mapes, Malik, Malloy, Meinhold, Michelogiannakis, Planerova, Rapoport, Rasubala, Rivera-Ramos, Shastri, Shope, Singh, Sommers, Tągankar, Tsigarida, Tzouma, Vorrasi, Winslow, Wong, Xiao

The Eastman Institute for Oral Health is an integrated entity within URMC responsible for research, education, and clinical care in oral health. It consists of the Eastman Department of Dentistry, the Center for Oral Biology, and the Eastman Dental Center.

The Eastman Institute for Oral Health offers graduate dental residency programs in postdoctoral general dentistry (advanced education in general dentistry and general practice residency), oral and maxillofacial surgery, orofacial pain, orthodontics, pediatric dentistry, periodontics, and prosthodontics.

In addition, the institute offers the Master of Science degree in dental sciences and cooperates with departments in the School of Medicine and Dentistry in offering programs leading to a PhD degree in one of the basic or health sciences. Both the MS and PhD programs are open only to postdoctoral students who already hold a DDS, DMD, or equivalent degree. These programs are integrated with advanced clinical training programs and are designed for those planning a career in teaching and research in dentistry.

The Center for Oral Biology is the research and academic component of the institute. Its programs and courses are described in this Bulletin within the EIOH listings.

400. Special Care I: Medical-Dental Inter-Relationships
Prerequisites: DDS, DMD, audit is optional for other healthcare professionals

This course will increase the understanding of diagnosis and dental treatment planning for patients who have medical conditions; to review current concepts of diagnosis and treatment of common medical problems that the dentist may encounter; and, to review specific and clinical cases where medical background influences dental treatment. (Fall)

401. Dentistry for Geriatric Patients and for People With Intellectual, Learning, and Developmental Disabilities

Older adults who have medical, physical, and mental health problems and people with intellectual, learning, and developmental disabilities may need special care when they have dental treatment. The population of these “special” patients is growing and they, like all of us, are retaining their teeth longer. This course, utilizing a seminar format, includes presentations, discussion, and case presentations about the nature of these problems and disabilities and how they can be addressed in modern dental practices. (Spring)

406. Instructional Design

Students will learn to review the process of designing instruction which include assessing learning needs leading to the design, development, presentation and evaluation of teaching materials. Included will be presentation skills as they relate to classroom teaching, presentations at conferences, patient teaching in the dental office and Web-based teaching. (Fall, even years)

407. Ethical Guidelines for the Dentist

The objective of this course is to establish a relationship between professionalism and ethical conduct in dentistry; understand the importance of effective communication; develop effective problem-solving techniques; evaluate organizational codes of ethics; discuss ethics in the research environment; discuss ethics in the written and social media and discuss ethical principles in education and professional development. (Fall)
408. Scientific Basic Safe Dental
This course will address the hazards posed by radiation, mercury, infection, nitrous oxide, fluoride, stress and other potential hazards during the delivery of care. Emphasis will be placed on the scientific basis of the hazards and means to reduce the potential harm. (Spring, odd years)

409. Temporalmand Joint Disorders
Providing some of the necessary skills needed to understand the disease process and appropriate treatment alternatives for patients presenting with facial pain will be covered in this course. The diagnosis and management of patients with facial pain requires a multidisciplinary approach. The scope of this series will be partially didactic and partially clinical. (Fall, odd years)

410. Head and Neck Anatomy
This course will review the gross anatomy of the head and neck. Lecture material will primarily include gross and cross-sectional anatomy. Where appropriate, histology will also be reviewed. Standard radiographs, sectional CT and MRI images, common developmental anomalies, and patient oriented problems will also be presented. Demonstrations of gross and sectional anatomy as well as radiologic anatomy will supplement the lectures. All lectures, cases, and laboratory demonstrations will cover material pertinent to dental medicine. (Fall, even years)

411. Oral Diseases & Pathologies
Prerequisite: DDS, DMD, audit is optional for other healthcare professionals

The objective of this course is to provide knowledge of oral diseases and pathologies, including principles of differential diagnosis, common diagnostic tests, oral lesions (reactive, benign, dysplastic and malignant), common oral diseases, histopathological characteristics of oral lesions, salivary gland diseases and tumors, cysts of the jaws and neck, odontogenic and non-odontogenic tumors, and common therapies in oral diseases. (Spring, odd years)

412. Oral Implantology
Prerequisite: Basic Dental Implantology course is suggested.

The objective of this course is to provide an advanced level, in-depth description of the anatomy, physiology and histology of the bone-implant interface, scientific basis for diagnosis and treatment planning, imaging, mechanobiology, surgical treatment execution for implant placement and hard and soft tissue enhancement and to incorporate technology into surgical and prosthetic planning. This course is designed at an advanced level. (Fall, even years)

413. Advanced Oral Implantology
This course will provide an advanced overview and detailed description of prosthetic aspects of dental implant therapies and their applications to clinical treatment as it relates to prosthodontics and maxillofacial prosthodontics and to incorporate technology into prostheses fabrication and assess diagnosis and treatment of complications in an evidence-based approach. This course is designed at an advanced level. (Spring, odd years)

414. Understanding Pain
This course presents an in-depth knowledge of advanced concepts in orofacial pain related to: 1) taxonomy of pain, 2) peripheral pain mechanisms, 3) dorsal horn mechanisms, 4) spinal mechanisms following nerve injury and inflammation, 5) modulation at a spinal level, 6) ascending spinal tracts, 7) supraspinal structures, 8) effects of the peripheral nervous system on brain activity, 9) clinical significance of inflammation and nerve injury, 10) descending opioid system and 11) motor control. (Spring, even years)

415. Practice Management
This course will provide information and material about all aspects of managing and running a dental practice. Guest lectures will include experts in the field of law, financial planning, and dealing with staff, banking, accounting, computers, equipment and practice. (Spring)

416. Advanced Oral Medicine
This course gives attendees an overview on oral manifestations of systemic diseases and conditions, covering systematically various organs and body systems. The course reviews the latest updates on these topics and extends on topics of special interest for dentists. (Spring, even years)

417. Principles of Evidence-Based Dentistry
This course will focus on the principles of evidence-based dentistry, with emphasis on writing brief critical evaluations of research literature. There are three parts to the course, highlighting the first three aspects of evidence-based practice for dentists: 1) Formulating answerable clinical questions; 2) searching the literature; and 3) critical appraisal of research articles. The critical appraisal section of the course covers hierarchy of evidence, research study types, and how to appraise articles for different clinical question categories. These categories include RCT/therapy, diagnosis, prognosis & etiology, and systematic reviews & meta-analyses. (Every Fall and Spring)

418. Oral Microbiology
This course covers the major groups of microorganisms causing oral disease with emphasis on basic biology, genetics, physiology, and pathogenic mechanisms. (Fall, odd years)

419. Dental Research Seminar
Prerequisite: For PhD and MS students, or Dental Residents; others with permission of the Instructor.

This seminar series provided experience to participants in preparing, organizing, and presenting material to a critical audience. The fall semester is devoted to a systematic review of recent significant research developments in one of the basic sciences fundamental to oral biology. In the spring, semester students report on original research. (Fall, Spring)
420. Biology of the Periodontium
Prerequisite: permission of instructor
Stressing the biological behavior of the periodontium, the course reviews the fundamentals as well as the latest developments in periodontal research. Topics covered are the development, morphology, and physiology of the periodontal tissues; the epidemiology, etiology, and histopathology of periodontal diseases, plus current concepts regarding mechanisms of periodontal tissue destruction and repair. (Spring, odd years)

421. Craniofacial Growth and Development
Prerequisite: permission of instructor
This course covers the prenatal embryogenesis and postnatal growth and development of the craniofacial complex. Mechanisms of growth control, the development of occlusion, and methods of study and timing are presented. Clinical implications for normal and abnormal facial development are discussed. (Spring, odd years)

422. Pharmacology & Therapeutics
This course presents a review of the principles of pharmacology, including mechanisms, pharmacodynamics, pharmacokinetics, adverse reactions, and contraindications of selected drug groups. This course will not present a comprehensive review of all drug classes, but instead, lectures will focus on selected, common classes of drugs used for the management of medical and dental disorders and diseases, with emphasis on those drug groups having relevance to dentistry. New and emerging agents and therapies will also be discussed. (Fall, odd years)

423. Oral Epidemiology I: Principles and Practice
Students are introduced to the fundamentals of epidemiology. Emphasis is placed on the natural history of common dental diseases. (Fall)

424. Oral Epidemiology II: Research Design and Analysis
Prerequisite: DEN 423 - Oral Epidemiology I: Principles & Practice
The objective of this course is to develop the ability to use statistical reasoning in planning studies and interpreting the resulting data; to acquire the statistical knowledge essential to the understanding and evaluation of the methodological aspect of publications in contemporary dental literature; and, to master the necessary statistical language in order to communicate with biostatisticians as research team members. (Spring)

425. Saliva and Salivary Glands
This course will concentrate on the biology of saliva and the salivary glands. The mechanics of saliva production, neuronal and pharmacologic impacts on gland physiology, the functional role of salivary proteins, and salivary gland diseases will be covered. The sensitivity and response of salivary glands to radiation, as well as mechanisms of radioprotection will be discussed. The course will also include clinical assessment methods, case presentations, and current topics in therapeutic treatments. (Spring, even years)

426. Fundamentals of Dental Caries
This course presents the latest developments in many aspects of dental caries, from the most fundamental basic science to clinical applications. (Fall)

440. Control of Pain & Anxiety Anesthesia Techniques
This course serves to provide an introductory program on pain and anxiety management from a practical anesthesia/patient care perspective with a focus on analgesia, moderate sedation and other methods of pain and anxiety control used to facilitate patient treatment. Lectures and seminars emphasize patient evaluation, risk assessment, sedation techniques, monitoring, adjunctive medications and the diagnosis and management of complications. (Summer)

441. Physical Diagnosis
This course serves to provide an introductory program and hopefully review of physical diagnosis used to facilitate patient treatment. Lectures and seminars emphasize patient evaluation, risk assessment and the diagnosis and management of common medical problems face in the management of the dental patient. (Summer)

442. Basic Concepts in Oral Surge
A basic overview of patient evaluation and risk assessment as they pertain to the management of common conditions managed by oral and maxillofacial surgeons will be covered in this course. Lectures and seminars emphasize patient evaluation, risk assessment, surgical techniques, and the diagnosis and management of complications. (Summer)

443. Basic Dental Implantology
This introductory course in Dental Implantology consists of lectures and simulation laboratory exercises to prepare students to place dental implants. (Fall)

493. Special Topics
495. Master’s Research
497. General Dentistry Practicum
School of Nursing

Administrative Officers

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Professor of Nursing
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Endowed Professor for Nursing Science and Professor of Nursing

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Independence Professor in Nursing and Palliative Care and Associate Professor of Nursing
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Associate Professor of Clinical Nursing
Grace Wlasowicz, PhD, RN, PMHNP-BC (Rochester)
Associate Professor of Clinical Nursing
Ying Xue, DNSc, RN (Yale)
Associate Professor of Nursing

Elaine Andolina, MS, RN (Rochester)
Assistant Professor of Clinical Nursing
Mina Attin, PhD, RN (California, Los Angeles)
Assistant Professor of Nursing
Erin Baylor, DNP, RN, PNP-BC, ONP (Chatham)
Assistant Professor of Clinical Nursing
Accreditation

All areas of study are approved by and registered with the State Education Department, University of the State of New York, Deputy Commissioner for the Professions, Office of Professions, Albany, New York 12234, (518) 474-1362. The Master’s and Doctor of Nursing Practice (DNP) graduate programs are fully accredited by the Commission on Collegiate Nursing Education, 655 K Street NW, Suite 750, Washington, D.C. 20001, (202) 463-6930.

PhD and MS-PhD Programs

PhD Program

The PhD program, established in 1978, prepares nurses and members of certain other health professions for leadership positions in teaching, research, clinical practice, and the health care system. In 2006, with the goal of promoting interdisciplinary research, the program changed its name from PhD in Nursing to PhD in Health Practice Research and expanded its admission eligibility beyond nursing to include other master’s-prepared licensed health professionals whose research interests are compatible with those of the faculty. In 2016 the name again was changed to PhD in Nursing and Health Science in order to retain the interdisciplinary nature of the curriculum while also ensuring that nurses are recognized among the diversity of health professionals enrolled in the program.

PhD graduates assume faculty positions, engage in innovative models of care through faculty practice, conduct research for the improvement of health care, and formulate health care policy. These roles require the ability to (1) identify the critical questions related to health, illness, and health care delivery, (2) engage in rigorous research concerning behavior in health and illness and the complex phenomena of health care delivery, and (3) use research findings to advance evidence-based practice.

Four components of this doctoral program address the development of these skills: (1) theory development and research methods courses, (2) support (cognate) courses, (3) clinically focused research courses, and (4) the dissertation. Research and teaching assistantship experiences totaling 360 hours are required in addition to the coursework and independent research.

A minimum of 60 semester credits in the four component areas is required. Up to 30 credits may be transferred from a previous master’s program to achieve the 90 credits required for a PhD from the University. Additional courses beyond the required minimum may be necessary, depending on the student’s research topic, specific career goals, and prior preparation. A PhD qualifying examination is given when Year 1 core courses are completed. The dissertation proposal defense completes the qualification process for advancement to candidacy. Proposal defense must be completed at least six months prior to final defense of the dissertation. The PhD is awarded following the successful defense of a written dissertation. Sample program plans are available on request.
**PhD Admission Requirements**

1. Master of Science degree from an accredited program in a health-related discipline.
2. Current clinical licensure.
3. Cumulative GPA of 3.0 for undergraduate work and 3.5 for graduate work preferred.
4. Completed PhD application.
5. Curriculum vitae.
6. Competitive scores on the Graduate Record Examination (general test only).
7. For international students for whom English is not the primary language or who did not complete their master's degrees in nursing in an English-speaking country, Test of English as a Foreign Language (TOEFL).
8. Favorable interview with faculty member(s), delineating goals and interests for research and doctoral study.
9. Positive letters of recommendation from at least three academicians familiar with the applicant's intellectual ability, academic achievement, research potential, and professional commitment.
10. Statement of applicant's goals and interests for doctoral study and an additional sample of writing.
11. Beyond the general requirements, during the admissions process strong consideration is given to the match of student research interests with faculty programs of research.

**MS-PhD Dual Degree Programs**

For highly motivated students with strong academic promise, six programs are offered that combine MS degrees in nurse practitioner specialties with the PhD. Graduates will be competent, advanced practice nurses and faculty who conduct clinical research and health services evaluations to improve practice in their chosen specialty areas. There also is an MS to PhD dual degree program in nursing education designed for nurses who want to prepare themselves for an academic teaching career that includes conducting research in their clinical interest areas.

The combined accelerated programs meet all requirements of both the MS and PhD programs in the School of Nursing. Completion of the PhD is accelerated by replacing MS-level research courses with PhD research courses and allowing PhD cognate credit for one course in the master's program. Students complete all coursework for both degrees in three calendar years, earn the MS degree, and go on to complete the PhD dissertation.

The total number of required MS-PhD program credits varies from 90 to 103, depending on the master's specialty of choice. Additional courses beyond required minimums may be necessary depending on the student's research topic, specific career goals, and prior preparation. Samples of specialty-specific combined program plans are available from the School of Nursing, Office of Student Affairs.

Both full-time and part-time study is permitted in the PhD program. MS-PhD students may only apply for a full-time program of study. Students admitted to the full-time PhD program require a minimum of three and one-half to four years to complete the program. Minimum completion time for the MS-PhD combined programs is four and one-half to five years of full-time study.

**MS-PhD Admission Requirements**

1. Bachelor of Science degree in nursing from an accredited program
2. RN licensure within the United States or U.S. territory
3. Master's degree specialty area identified as part of the admissions process
4. One year of clinical experience in appropriate specialty area prior to admission: Adult Gerontology Acute Care Nurse Practitioner—medical/surgical experience is required; Pediatric Nurse Practitioner—pediatric experience is preferred; Pediatric Nurse Practitioner/Neonatal Nurse Practitioner—two years of neonatal critical care staff nurse experience is required; Adult Gerontology or Family Nurse Practitioner—nursing experience is preferred
5. Nursing cumulative grade point average of 3.0 preferred for undergraduate work
6. Statistics course with grade of “B” or above
7. Completed MS-PhD application
8. Curriculum vitae
9. Typewritten professional statement
10. Sample of scholarly writing
11. Competitive scores on the Graduate Record Examination (general test only)
12. Three positive letters of recommendation that speak to the applicant's professional and intellectual abilities and achievements, potential as an advanced practice nurse, research potential, and professional commitment. One reference should be from a master's prepared nurse manager/supervisor in the clinical setting. Others should be from PhD-prepared academicians.
13. Favorable interviews with two SON faculty members delineating goals and interests for combining a clinical master's degree with the PhD degree
14. For International students only: TOEFL scores >88 i-based

Beyond the general requirements, during the admissions process strong consideration is given to the match of student research interests with faculty programs of research.

**Financial Assistance**

Full tuition scholarships, up to 60 credits, may be granted to full-time PhD students, and for 60 credits of PhD-level coursework for full-time students in the MS-PhD combined programs depending on availability of funds. Some School of Nursing stipend support may be available for full-time PhD study, again depending on availability of funds. Applicants may be considered for highly competitive University-wide funding if applications are received by February 1. Students who are employees of the Strong Health system may be eligible for tuition benefits. There are opportunities for paid, part-time teaching or research assistantships in the School of Nursing. For those who are eligible, submission of a National Research Service Award application is strongly encouraged. A variety of other external funding sources may be explored through resources in the School of Nursing.
DNP Program

The Doctor of Nursing Practice (DNP) program was established in 2007. This clinical doctorate prepares advanced practice nurses (nurse practitioners and clinical nurse leaders) to lead the development, implementation, and evaluation of evidence-based interventions to optimize the delivery and outcomes of care. DNP graduates assume roles in a wide variety of direct and indirect care roles such as clinicians, quality improvement directors, informaticists, health care executives, faculty members, professional appointees, and policy advocates.

Students complete coursework in evidence-based practice, performance improvement, translational research, clinical data management, epidemiology, leadership, systems management, health policy, informatics, and interprofessional partnerships. At the completion of the program, students are required to defend an evidence-based scholarly project.

Students may enter the DNP program as post-baccalaureate students or post-master’s students. Credits may be transferred from previous master’s study. Students admitted to the post-baccalaureate DNP program can complete the program in five years. Those admitted to the post-master’s DNP typically complete the program in three years. Sample program plans are available on request.

DNP Admission Requirements

1. A bachelor’s or master’s degree in nursing and official transcripts from all college-level study reflecting a cumulative GPA of 3.0 for undergraduate work and 3.5 for graduate work preferred
2. National certification in an advanced practice nursing specialty (post-MS, if applicable)
3. Curriculum vitae
4. Positive letters of recommendation from a doctorally prepared academician, a supervisor in an employment setting, and a practicing RN (or APN) familiar with the applicant’s intellectual ability, academic achievement, and professional commitment
5. Professional goal statement describing career objectives and areas of clinical interest
6. Writing sample (academic paper, publication, or other written work on which applicant is first or sole author)
7. For international students, TOEFL with a minimum score of 560 (paper-based), 230 (computer-based) or 88 (iBT)
8. Interview with specialty program faculty (MS if post-MS application) and DNP program director to discuss a potential program of study, area of interest, and future professional goals

Financial Assistance

Financial assistance is not generally available through School of Nursing scholarships. Area health care institution reimbursement is the most common form of aid. Additional information on outside opportunities and sources of support is available on the School of Nursing website (www.son.rochester.edu).

Accelerated BS and MS for Registered Nurses

This is an accelerated Bachelor of Science and Master of Science degree program (RN to BS to MS program) for registered nurses whose original educational preparation was received in a diploma or associate degree-granting institution. The program is specifically designed for registered nurses who have identified a nurse practitioner master’s degree as their educational goal and who possess the motivation and potential to complete graduate studies. Up to 96 credits may be transferred from prior coursework (64 arts and sciences credits and 32 nursing credits) to be applied toward the RN to BS to MS program. This may result in the applicant needing to take only three undergraduate bridge courses (12 credits) in addition to the master’s program curriculum. Professional nurses who have an associate’s degree or diploma with a major in nursing, and very strong grades, are eligible to apply for admission to the RN to BS to MS program for part-time study.

Accelerated Master’s Program for Non-Nurses (AMPNN)

This is a program for entry into nursing for second-degree students (non-nurses with a baccalaureate degree in another discipline). Students should have substantial experience in the health care field and very strong grades for this program. The program includes an accelerated generalist baccalaureate degree in nursing to be completed in 12 calendar months of full-time study. Upon successful completion of the generalist curriculum, the BS is awarded and students are eligible for the registered nurse licensing examination (NCLEX). Following completion of the generalist curriculum, students move into one of the MS nurse practitioner specialty programs. These programs can be completed in an additional two years of full-time study. Students choosing the Acute Care specialty need one year of experience as an RN prior to beginning clinical coursework at the master’s level. At the successful completion of the specialist curriculum, students are awarded the MS degree and are eligible for nurse practitioner certification at both the state and national level.

Course descriptions for year-one baccalaureate-level coursework in the AMPNN can be found in the Official Bulletin, Undergraduate Studies (also on the web at www.rochester.edu/Bulletin).

Master’s Programs

The School of Nursing offers Master of Science degrees with a clinical concentration (nurse practitioner programs), education focus (master’s in nursing education), or a leadership focus (health care organization management and leadership or clinical nurse leader). The clinical programs are for nurses who want to expand their skill sets and explore new opportunities as care providers. Graduates assume a variety of roles in hospital,
outpatient, and community settings. The Master of Science Program in Nursing Education is designed to prepare nurses as educators to function in a variety of settings. The leadership program is an interdisciplinary program for both nurses and other health care professionals ready to take their careers to the next level and influence health systems.

**Nurse Practitioner Master’s Programs and Post-Master's Programs**

Professional nurses who have baccalaureate degrees with a major in nursing are eligible to apply for admission to full- or part-time study in the master's nurse practitioner programs. There are several areas of concentration in the nurse practitioner programs, which provide an opportunity for depth and breadth of preparation in nursing specialty (population) areas, and for role development as scholarly advanced practitioners and leaders. While each clinical nursing area has its special requirements, there are common substantive areas of study including theory, evidence-based practice, ethics, and public policy. All areas of concentration require completion of from 45 to 55 credits in addition to 616–932 hours of supervised clinical experience for the degree. Students are responsible for planning, in consultation with their faculty advisors, a course of study designed to complete the degree requirements. Continuing study beyond the master's degree is encouraged, based on individual goals and interests.

Nurse practitioner specialties include Adult-Gerontology Acute Care Nurse Practitioner, Adult-Gerontology Primary Care Nurse Practitioner, Pediatric Nurse Practitioner, Pediatric Nurse Practitioner/Neonatal Nurse Practitioner, Family Nurse Practitioner, Gerontological Nurse Practitioner (Post-Master's only), and Family Psychiatric Mental Health Nurse Practitioner Program.

**Adult-Gerontology Acute Care Nurse Practitioner**
The adult-gerontology acute care nurse practitioner graduate nursing specialty prepares students for advanced practice positions as nurse practitioners in acute or critical care. Clinical skills necessary for solving clinical problems, for planning and managing health care for a specialty group of patients, and for identifying and exploring researchable questions are developed. The specialty offers students opportunities to study in a variety of acute and chronic care settings. Critical appraisal of how advanced practice nurses affect patient care delivery and health care practices at the institutional, local, and national level is undertaken. Graduates of the specialty are eligible for New York State and national certification as acute care nurse practitioners.

**Pediatric Nurse Practitioner, Pediatric Nurse Practitioner/Neonatal Nurse Practitioner**
This specialty prepares advanced practice nurses as pediatric or pediatric/neonatal nurse practitioners. Students acquire the knowledge, attitudes, and skills necessary to work with healthy children, as well as those affected by acute and chronic diseases and disabilities. Students are prepared to function independently and as part of an interdisciplinary team. Emphasis is placed on identifying the empirical and theoretical bases of pediatric nurse practitioner roles. Case management skills working with individual clients and groups are developed. This specialty is based on an understanding of normal and abnormal physical and psychosocial development and aimed equally at health promotion, maintenance, and restoration. Graduates are eligible for New York State and national certification as pediatric or pediatric/neonatal nurse practitioners.

**Adult-Gerontology Primary Care and Family Nurse Practitioner**
The graduate specialties in primary care prepare the nurse practitioner student for advanced practice in a variety of health care delivery systems. In community-based clinical settings that provide primary health care, students develop the skills necessary to identify, manage, and refer commonly occurring health problems, to maintain health, and to prevent illness. Graduates of these specialties are eligible for New York State and national certification as family or adult-gerontology primary care nurse practitioners and are uniquely prepared to provide primary care to populations across the specialty-specific lifespan with unmet needs, particularly the socially and economically impoverished and underserved, and the chronically ill.

**Family Psychiatric Mental Health Nurse Practitioner**
This specialty is designed to prepare advanced practice nurses who are competent to provide care and assume leadership roles in the care of patients with psychiatric/mental health needs. Graduates are eligible for New York State and national certification as psychiatric/mental health nurse practitioners.

**Admission Requirements for Nurse Practitioner Master’s Programs**
- An introductory course in statistics, with a grade of C or higher, is prerequisite for admission to all master’s programs. Applicants (except to AMPNN) must give evidence of the fulfillment of legal requirements for the practice of nursing in some state in the United States or its territories. Personal interviews with faculty members may be required as part of the admission process. These interviews may be conducted by telephone if necessary.
- Completion of a bachelor’s degree in nursing from an accredited school of nursing
- Professional statement with career goals, résumé/CV, and writing sample (AMPNN requires only the statement and résumé/CV)
- Two favorable references that address professional and/or academic ability
- Official transcripts of all previous college-level academic work and evidence of cumulative 3.0 GPA preferred
- TOEFL scores (>360 for paper-based test, >88 for i-based test, and >230 for computer-based test) for international students

Once accepted for admission, all prospective students MUST comply with University and New York State immunization requirements prior to beginning coursework. Students are responsible for providing annual verification of immunization updates. A current license to practice nursing must be on file.
with the School of Nursing (except AMPNN in year one), where licensure as a registered nurse is required for clinical coursework.

**The Master of Science Program in Nursing Education**
The 35-credit Master of Science in Nursing Education program is comprised of a mix of core and education courses and is designed to prepare nurses as educators to function in a variety of settings. This unique program is hybrid-online, interprofessional, and based on a cognitive apprenticeship model. Three of the courses are taught with the Warner School of Education and the School of Medicine and Dentistry faculty to provide graduate students with opportunities to apply educational theory and evidence to teach effectively, work in diverse teams, lead change, use technology to inspire learning, and engage in scholarly inquiry.

**Admission Requirements for Master's in Nursing Education**
1. Completion of a bachelor’s degree in nursing from an accredited college or university
2. RN licensure within the United States or U.S. territory, or equivalent
3. Cumulative GPA of 3.0 on a 4.0 scale from a bachelor's degree program is preferred
4. Completion of a statistics course with a C grade or higher
5. Submission of a professional goal statement outlining reasons for seeking admission to the program
6. Writing sample (prior term paper, published article)
7. Two favorable references that address professional and/or academic and leadership ability; it is desirable that one of the letters be from a professional in health care
8. Personal interview(s) with program faculty members
9. A minimum previous work requirement of one year as a Registered Nurse is preferred
10. TOEFL scores (>560 for paper-based test, >88 for i-based test, and >230 for computer-based test) for international students.

**Master of Science—Leadership in Health Care Systems**
The Leadership Program is an interprofessional platform designed to prepare nurses and non-nurses for the challenges of managing and leading health systems in the 21st century. The Leadership Program is part time, with graduates earning an MS in Leadership in Health Care Systems in 16–18 months.

Students take a core group of courses in leadership and select from one of two concentrations: Health Care Organization Management and Leadership or Clinical Nurse Leader (CNL—open to RNs only). Thirty (30) and 35 credits, respectively, of academic coursework are needed for graduation.

Modeled after executive business programs, the core didactic content reflects competencies essential for health care leaders in the 21st century. The content in the two concentrations reflects specialty knowledge and professional competencies. Progression through the program builds a foundation for the final leadership capstone project where students work with a health care organization to experience real world issues, apply their leadership skills, and complete a capstone project of interest to the host organization.

**Admission Requirements for the Health Care Organization Management and Leadership Concentration**
1. Completion of a bachelor’s degree from an accredited college or university.
2. Cumulative GPA of 3.0 (on a 4.0 scale) preferred from a bachelor's degree program.
3. Statistics course with a grade of C or above.
4. Professional statement.
5. Two favorable references that address professional and/or academic ability and leadership ability. It is desirable that one of the letters be from a professional in health care.
6. Personal interview(s) with program faculty members.
7. There is no minimum work requirement for the interprofessional leadership program. Successful candidates are able to demonstrate academic ability, leadership experiences, and accomplishments in a variety of settings, and contributions to groups and communities through volunteerism or community service activities.
8. TOEFL scores (>560 for paper-based test, >88 for i-based test, and >230 for computer-based test) for international students.
9. Writing sample (prior term paper, published article).

**Admission Requirements for the Clinical Nurse Leader Concentration**
1. Completion of a Bachelor of Science degree in nursing from an accredited school (for the post-master's CNL, a master's degree is also required)
2. RN licensure within the United States or a U.S. territory
3. Cumulative GPA of 3.0 (on a 4.0 scale) preferred from a baccalaureate program
4. Statistics course with a grade of C or above
5. Professional statement
6. Clinical practice exemplar relating to patient care that describes what happened, the intent and the outcomes of actions and interactions with other members of the health care team
7. Two letters of reference that address clinical expertise and leadership talent (one of which is from an immediate supervisor)
8. Personal interview
9. A minimum of three years of employment as a registered nurse in a clinical setting (preferred)
10. Writing sample (prior term paper, published article)
Graduate Program Curricula

Specific course and clinical requirements for each specialty can be found on the web: www.son.rochester.edu/programs.

The School of Nursing reserves the right to cancel courses with insufficient enrollment. Curriculum revision at the graduate level is continuous and courses may be modified.

MS NURSE PRACTITIONER CORE COURSES

NUR 400. Research Principles for Evidence-Based Practice
Credit—five hours

This course is designed to prepare advanced practice nurses in applying theory to inform research and evidence to practice and using evidence to drive clinical decision-making. Students will learn the foundations of research methods that underlie evidence based practice. The course focuses on developing clinical questions, analyzing clinical data, evaluating pertinent evidence-based research, and ties this to a theoretical framework that will in turn guide clinical practice recommendations. Students will also explore outcomes in the contexts of professional practice using the theoretical framework soundly based on evidence. Students will gain a greater appreciation of how theory and evidence-based practice articulate and how best to apply theory to a clinical problem and measure outcomes.

NUR 401. The Writing Workshop
Credit—one hour

The purpose of this course is to help students gain proficiency in writing. It will provide graduate students with the essential tools for scholarly writing. Rules of grammar, punctuation, format, and composition will be reviewed and practiced. Styles of composition will be analyzed and applied in writing exercises. The importance of focused presentation of ideas, and clarity and progression of thought will be emphasized.

NUR 403. Ethics and Public Policy in the Health Care System
Credit—three hours

This foundational course provides an overview of the structure, regulation, and financing of the health care system in the United States. Nursing’s past and present contributions and its potential to shape future health care are evaluated. Contemporary health care and policy issues are examined using concepts and principles of planned change, ethical decision-making, the policy process, and policy analysis.

NUR 407. Advanced Physiology & Pathophysiology
Prerequisite: B.S. degree in Nursing
Credit—four to five hours

A study of those physiological and pathophysiological processes that are a basis for advanced nursing practice. The focus is on regulatory mechanisms that maintain homeostasis and the clinical problems that arise in the pathophysiological state. Content is based on theories from physiologic and immunologic research. This course is offered with varying credit and consists of (Unit I) cell physiology and immunology; (Unit II) neurophysiology and endocrinology; (Unit III) cardiovascular and respiratory physiology; and (Unit IV) renal and gastrointestinal physiology.

NUR 419. Advanced Pharmacology
Prerequisite: Introductory courses in Human Physiology and Pharmacology or their equivalent.
Credit—three hours

This is an advanced course in pharmacology that includes: interpretation of New York state and federal laws and regulations pertaining to prescribing drugs and record keeping; pharmacokinetics, pharmacotherapeutics and clinical decision making in drug management for the advanced practice of nursing.

NUR 492. Clinical Practicum
Credit—none

Varies based on independent study

NUR 493. Comprehensive Examination
Credit—none

CLINICAL SPECIALTY COURSES

Adult-Gerontology Acute Care Nurse Practitioner

NUR 410. Advanced Health Assessment
Prerequisite: Undergraduate physical assessment course including content equivalent to NUR 362 within 5 years OR NUR 363 Comprehensive Health Assessment Refresher OR permission of the course coordinator by petition.
Credit—four hours (two didactic, two lab)

This graduate level course provides the theoretical and clinical foundation for advanced comprehensive assessment of the health status of individuals and families. Building on undergraduate preparation, principles of complex interviewing and history-taking, diagnostic reasoning, and advanced physical, psychosocial, cultural, developmental, and environmental assessment are presented. From a functional and developmental base, the course will emphasize techniques for discrimination and analysis of common abnormal findings, the process of differential diagnosis, and methods for presentation of findings. Theoretical contexts of health promotion will be discussed and applied to clinical findings. This course will include comprehensive laboratory modules for specialty skill instruction.

NUR 411. Evaluation and Management of Adult Lifespan Patients
Prerequisite: NUR 410
Credit—eight hours (four didactic, four clinical)

This course focuses on promoting students’ critical thinking and decision making as they gain skills in evaluating and managing common health complaints in patients across the adult-older adult lifespan, which includes older adolescents, young adults, middle-aged adults, older adults, and frail elders. Students have
the opportunity to integrate advanced assessment concepts as they apply biopsychosocial and pharmacological concepts to formulate differential diagnoses and management plans for various patient populations. Coursework focuses on developing the advanced practice role within the context of a comprehensive and interprofessional approach to patient care.

**NUR 414. Nurse Practitioner Procedure Lab**

*Prerequisite: Currently matriculated NP students who have completed NUR 411; this course may be taken concurrently with NUR 449 for FNP students.*

*Credit—one hour*

This course provides nurse practitioner students with a laboratory/simulation experience that allows for skill acquisition of common clinical practice procedures and evaluation of commonly performed clinical tests. Students in the Primary Care programs (AGPCNP and FNP) and Acute Care NP program (AGACNP) are eligible to take this course following their initial clinical course (NUR 411). Prior familiarity with basic cardiac rhythm interpretation is expected.

**NUR 424. Adult Gerontology Acute Care Nurse Practitioner I**

*Prerequisite: NUR 403, 411, 414*

*Credit—nine hours (five didactic, four clinical)*

This course is the first in a two-course sequence for Adult Gerontology Acute Care Nurse Practitioner (AGACNP) students. The course builds on the concepts of advanced health assessment and the diagnosis and management of common problems across the adult-older adult-spectrum. Content focuses on the care of adults-older adults who have acute, critical, and/or complex care needs. Content addresses the foundations of acute and critical care that cross all areas of specialization. Clinical experiences and a variety of teaching-learning methods are utilized. Role development content emphasizes integration of the multiple roles for advanced practice nurses in an interdisciplinary, rapidly-changing health system. Students are expected to begin to implement the role of AGACPNPs across care settings.

**NUR 425. Adult Gerontology Acute Care Nurse Practitioner II**

*Prerequisite: Prerequisites: NUR 424*

*Credit—eight hours (four didactic, four clinical)*

This course is the second in a two-course sequence for AGACNP students. It is designed to prepare students for advanced practice in the care of adults and older-adults with acute, critical, and complex illnesses. The course is a continuation of NUR 424: AGACNP I. Content addresses the multiple specialty areas encountered in acute, critical, and complex care, both in direct care and system support roles. Clinical experiences and a variety of teaching-learning methods are utilized to allow students to become increasingly independent in their own clinical practice with respect to critical thinking and problem solving. By end of the course, the student will have developed entry-level competency in advanced practice nursing of adults and older adults with acute, critical, and complex health care needs.

**Pediatric Nurse Practitioner**

**NUR 412. Advanced Pediatric Health Assessment and Care of Well Children and Adolescents**

*Prerequisite: Undergraduate health assessment within 5 years or NUR 363 (Health assessment refresher).*

*Credit—five hours (three didactic, two clinical)*

This graduate level course provides the theoretical and clinical foundation for advanced comprehensive pediatric health assessment. Students will develop the necessary expertise to provide primary health care to well children and adolescents. Students will gain experience interviewing pediatric clients and their families and providing relevant anticipatory guidance, using age-appropriate techniques. Students will engage in health teaching regarding common pediatric health care concerns, including the provision of nutritional and breastfeeding advice, immunization guidance, promotion of healthy habits, safety promotion and injury prevention, and the management of common child behavioral issues. In addition, students will apply health and developmental screening techniques, and conduct age-appropriate physical examinations of infants, children and adolescents. Emphasis will be placed on the identification of normal and abnormal findings, as well as assessment of growth and development. Diagnostic reasoning analysis using the techniques of inspection, palpation, percussion and auscultation will be applied to all body systems, and the process of differential diagnosis will be developed. Course content will support students’ clinical experience in the provision of primary health care to well infants, children, adolescents, and their families. Family and PMH NP students take this course as part of their enrollment in NUR 410, Advanced Health Assessment across the Lifespan.

**NUR 437. Pediatric Primary Care I**

*Prerequisite: NUR 419: Advanced Pharmacology NUR 407: Advanced Physiology and Pathophysiology; NUR 412: Advanced Pediatric Health Assessment and Care of Well Children and Adolescent*

*Credit—seven hours (five didactic, two clinical)*

This is the first in a sequence of three clinical courses designed to prepare students for leadership roles in the advanced nursing care of children and families within a culturally diverse society. Emphasis will be placed on assessment and management strategies with children and adolescents who are well or who are experiencing minor health problems commonly encountered in primary care settings. Course content will be guided by a variety of theoretical and empirical perspectives relevant to clinical practice. Students will develop physical and psychosocial assessment and intervention skills specific to the pediatric population, using a diagnostic reasoning process. Clinical practice sites will include a variety of primary care settings.
NUR 438. Pediatric Primary Care II
Prerequisite: Graduate nursing students specializing in the care of children and families who have satisfactorily completed master level nursing research, pharmacology, NUR437 and all of its prerequisites, and, for those in the neonatal track, Nursing 436.
Credit—six hours (three didactic, three clinical)

This is the second of three clinical courses designed to prepare students for advanced nursing care of children and families within a culturally diverse society. The course has two major emphases: 1) beginning development of leadership and health management skills, and 2) development of competency in assessment and intervention strategies for children experiencing increasingly complex health, social and/or behavioral problems, and their families. Nursing, developmental, family systems, role, organizational, leadership and other theoretical frameworks are used to examine the impact of complex health problems on children, families and society. Students also use these foundations to build abilities to plan, implement and evaluate strategies and programs for promoting optimal outcomes for children and families experiencing acute or chronic illness or disability.

NUR 439. Pediatric Primary Care III
Prerequisite: Prerequisites for this course include the successful completion of NUR 410 or 412, NUR 437, and NUR 438.
Credit—seven hours (three didactic, four clinical)

This is the third of three clinical courses designed to prepare students for leadership roles in the advanced nursing care of children and families within the context of a culturally diverse society and complex health care systems. The course has two major emphases. The first is on further development of leadership and health care management skills, with special emphasis on integrated delivery systems, managed care, reimbursement structures, interdisciplinary team building, and case management from both a community and population perspective. The focus in this area of emphasis is on developing skills for independence in indirect care, and on overcoming systems barriers as a change agent in health care for children and their families. The second emphasis is on development of competency in advanced nursing practice with children and adolescents who are experiencing the most complex health conditions, and their families.

NUR 452. Pathophysiology and Psychopharmacology of Mental Health Disorders Across the Lifespan I
Prerequisite: Matriculated into program and/or by permission of the instructor NUR 407 Advanced Pathophysiology NUR 419 Advanced Pharmacology NUR 450 Psychiatric Diagnosis across the Lifespan (Pre or Co-requisite)
Credit—three hours

Pathophysiology of Mental Illness and Psychopharmacology across the Lifespan I offers an in-depth investigation of the neurobiological basis of major psychiatric illnesses for individuals across the lifespan. This foundational course allows the student to apply knowledge of pathophysiology, pharmacokinetics, and pharmacodynamics to design, analyze and evaluate pharmacological treatment regimes informed by research evidence and best practice guidelines. This course is taught primarily online.

Family Nurse Practitioner

NUR 410. Advanced Health Assessment
Prerequisite: Undergraduate physical assessment course including content equivalent to NUR 362 within 5 years OR NUR 363 Comprehensive Health Assessment Refresher OR permission of the course coordinator by petition.
Credit—six hours (four didactic, two lab)

This graduate level course provides the theoretical and clinical foundation for advanced comprehensive assessment of the health status of individuals and families. Building on undergraduate preparation, principles of complex interviewing and history-taking, diagnostic reasoning, and advanced physical, psychosocial, cultural, developmental, and environmental assessment are presented. From a functional and developmental base, the course will emphasize techniques for discrimination and analysis of common abnormal findings, the process of differential diagnosis, and methods for presentation of findings. Theoretical contexts of health promotion will be discussed and applied to clinical findings. This course will include comprehensive laboratory modules for specialty skill instruction.

NUR 411. Evaluation and Management of Adult Lifespan Patients
Prerequisite: NUR 410
Credit—six hours (four didactic, two clinical)

This course focuses on promoting students' critical thinking and decision making as they gain skills in evaluating and managing common health complaints in patients across the adult-older adult lifespan, which includes older adolescents, young adults, middle-aged adults, older adults, and frail elders. Students have the opportunity to integrate advanced assessment concepts as they apply biopsychosocial and pharmacological concepts to formulate differential diagnoses and management plans for various patient populations. Coursework focuses on developing the advanced practice role within the context of a comprehensive and interprofessional approach to patient care.

NUR 413. Family Theoretical Frameworks and Application to Nursing Care of Families
Credit—three hours

This course examines theoretical frameworks relevant to family nursing interventions. The family in health and illness and the impact of transitions, crises, and stressful events on families are explored. Clinical situations with families are examined and analyzed in light of theory and concepts. Students examine their own beliefs and family life experiences as these relate to their developing practice of family nursing.
NUR 414. Nurse Practitioner Procedure Lab
Prequisite: Currently matriculated NP students who have completed NUR 411; this course may be taken concurrently with NUR 449 for FNP students.
Credit—one hour

This course provides nurse practitioner students with a laboratory/simulation experience that allows for skill acquisition of common clinical practice procedures and evaluation of commonly performed clinical tests. Students in the Primary Care programs (AGPCNP and FNP) and Acute Care NP program (AGACNP) are eligible to take this course following their initial clinical course (NUR 411). Prior familiarity with basic cardiac rhythm interpretation is expected.

NUR 437. Pediatric Primary Care I
Prequisite: NUR 419: Advanced Pharmacology NUR 407: Advanced Physiology and Pathophysiology; NUR 412: Advanced Pediatric Health Assessment and Care of Well Children and Adolescent
Credit—four hours

This is the first in a sequence of three clinical courses designed to prepare students for leadership roles in the advanced nursing care of children and families within a culturally diverse society. Emphasis will be placed on assessment and management strategies with children and adolescents who are well or who are experiencing minor health problems commonly encountered in primary care settings. Course content will be guided by a variety of theoretical and empirical perspectives relevant to clinical practice. Students will develop physical and psychosocial assessment and intervention skills specific to the pediatric population, using a diagnostic reasoning process. Clinical practice sites will include a variety of primary care settings.

NUR 444. Adult-Gerontology Primary Care I
Prequisite: NUR 411
Credit—eight hours (four didactic, four clinical)

In this course clinical experience, seminars, and topical discussions provide an opportunity for synthesis and integration in all aspects of care for the advanced practice primary care nurse practitioner (NP). Content relating to the natural history of health and disease across the adult lifespan (older adolescence through frail older adults) is explored. Students will acquire an expanded perspective of the NP’s role as a skilled clinician, professional colleague, consultant, and leader. The provision of primary care to patients over an extended period of time allows the student to share in the responsibility and accountability of clinical practice while attending to the needs of individuals, families, communities, and organizations.

NUR 445. Adult-Gerontology Primary Care II
Prequisite: NUR 444
Credit—seven hours (three didactic, four clinical)

This course is a continuation of NUR 444, Adult-Gerontology Primary Care I, with seminars, clinical topic discussions, case examples, and clinical practicum. Special emphasis is placed on advanced application of the domains of theory, evidence-based practice, ethics, and public policy to the clinical evaluation and management of patients along the full lifespan, for FNP students, and the adult-older adult spectrum, for the AGPCNP student. Content specifically focused on care of older adults is included and builds on content offered in the previous clinical courses.

NUR 449. Women’s Health Care for Primary Care Generalists
Prequisite: Completion of at least the first clinical course of the student’s primary care clinical sequence is prerequisite to this course.
Credit—three hours (one didactic, two clinical)

This course is designed to prepare primary care students for advanced practice in the reproductive health care of women. The course focuses on the management of the most commonly encountered obstetric and gynecologic health care needs for the healthy woman throughout her adolescent and adult years, with the explicit understanding that the woman is an active partner in her own care. The course emphasizes consideration of each woman’s health within the unique context of her physical, interpersonal and sociocultural environments and encourages analysis of resources and deficits for health from both the individual and health systems perspective. Critical synthesis of research for application to practice is stressed.

Adult-Gerontology Primary Care Nurse Practitioner

NUR 410. Advanced Health Assessment
Prequisite: Undergraduate physical assessment course including content equivalent to NUR 362 within 5 years OR NUR 363 Comprehensive Health Assessment Refresher OR permission of the course coordinator by petition.
Credit—four hours (two didactic, two lab)

This graduate level course provides the theoretical and clinical foundation for advanced comprehensive assessment of the health status of individuals and families. Building on undergraduate preparation, principles of complex interviewing and history-taking, diagnostic reasoning, and advanced physical, psychosocial, cultural, developmental, and environmental assessment are presented. From a functional and developmental base, the course will emphasize techniques for discrimination and analysis of common abnormal findings, the process of differential diagnosis, and methods for presentation of findings. Theoretical contexts of health promotion will be discussed and applied to clinical findings. This course will include comprehensive laboratory modules for specialty skill instruction.

NUR 411. Evaluation and Management of Adult Lifespan Patients
Prequisite: NUR 410
Credit—eight hours (four didactic, four clinical)

This course focuses on promoting students’ critical thinking and decision making as they gain skills in evaluating and managing common health complaints in patients across the adult-older adult lifespan, which includes older adolescents, young adults,
middle-aged adults, older adults, and frail elders. Students have the opportunity to integrate advanced assessment concepts as they apply biopsychosocial and pharmacological concepts to formulate differential diagnoses and management plans for various patient populations. Coursework focuses on developing the advanced practice role within the context of a comprehensive and interprofessional approach to patient care.

NUR 414. Nurse Practitioner Procedure Lab
Prerequisite: Currently matriculated NP students who have completed NUR 411; this course may be taken concurrently with NUR 449 for FNP students.
Credit—one hour

This course provides nurse practitioner students with a laboratory/simulation experience that allows for skill acquisition of common clinical practice procedures and evaluation of commonly performed clinical tests. Students in the Primary Care programs (AGPCNP and FNP) and Acute Care NP program (AGACNP) are eligible to take this course following their initial clinical course (NUR 411). Prior familiarity with basic cardiac rhythm interpretation is expected.

NUR 444. Adult-Gerontology Primary Care I
Prerequisite: NUR 411
Credit—eight hours (three didactic, four clinical)

In this course clinical experience, seminars, and topical discussions provide an opportunity for synthesis and integration in all aspects of care for the advanced practice primary care nurse practitioner (NP). Content relating to the natural history of health and disease across the adult lifespan (older adolescence through frail older adults) is explored. Students will acquire an expanded perspective of the NP’s role as a skilled clinician, professional colleague, consultant, and leader. The provision of primary care to patients over an extended period of time allows the student to share in the responsibility and accountability of clinical practice while attending to the needs of individuals, families, communities, and organizations.

NUR 445. Adult-Gerontology Primary Care II
Prerequisite: NUR 444
Credit—seven hours (three didactic, four clinical)

This course is a continuation of NUR 444, Adult-Gerontology Primary Care I, with seminars, clinical topic discussions, case examples, and clinical practicum. Special emphasis is placed on advanced application of the domains of theory, evidence-based practice, ethics, and public policy to the clinical evaluation and management of patients along the full lifespan, for FNP students, and the adult-older adult spectrum, for the AGPCNP student. Content specifically focused on care of older adults is included and builds on content offered in the previous clinical courses.

Family Psychiatric Mental Health Nurse Practitioner

NUR 415. Advanced Health Assessment -- Lifespan
Credit—four hours (three didactic, one lab)

This graduate level course focuses on providing students with advanced knowledge and skills in health assessment of individuals across the lifespan within the context of the advanced practice role. Building on undergraduate preparation, principles of complex interviewing and history-taking, diagnostic reasoning, and advanced physical, psychosocial, cultural, developmental, and environmental assessments are presented. From a functional and developmental base, the course emphasizes techniques for recognition of common abnormal findings, identification of risk factors, and documentation of assessment findings. This course includes opportunities for hands-on practice of physical assessment skills, simulation, and case-based activities with ongoing feedback.

NUR 450. Psychopathology and Psychiatric Assessment and Diagnosis Across the Lifespan
Prerequisite: Matriculation into the program or with instructor permission.
Credit—five hours

This course provides students with a biopsychosocial framework for the advanced practice of psychiatric mental health nursing with individuals of various ages and cultural backgrounds. Knowledge of evidence-based practice for common mental health problems, major psychiatric disorders, and substance use disorders is emphasized, using recovery-focused principles. Students apply knowledge and skills in the assessment, differential diagnosis, and formulation of major psychiatric disorders based on selected taxonomies, including identification of organic causes and medical comorbidity contributing to alterations in biopsychosocial functioning.

NUR 451. Individual Psychotherapy Across the Lifespan
Prerequisite: NUR 455, 450 prerequisite or instructor permission.
Credit—four hours

This course is a systematic exploration of the theory and evidence-based practice of providing psychotherapy for specific disorders and age groups across the lifespan. This course builds upon the student’s knowledge of psychosocial development, mental health assessment, and psychopathology. Therapy models, derived from various theoretical frameworks, are applied to cases examples. The process of the psychotherapeutic relationship is examined. Attention is given to the cultural, ethical, legal, and public policy implications of providing psychotherapy for individuals of various ages and cultural backgrounds. This course is taught primarily online.
NUR 452. Pathophysiology and Psychopharmacology of Mental Health Disorders Across the Lifespan I
Prerequisite: Matriculated into program and/or by permission of the instructor NUR 407 Advanced Pathophysiology NUR 419 Advanced Pharmacology NUR 450 Psychiatric Diagnosis across the Lifespan (Pre or Co-requisite)
Credit—three hours
Pathophysiology of Mental Illness and Psychopharmacology across the Lifespan I offers an in-depth investigation of the neurobiological basis of major psychiatric illnesses for individuals across the lifespan. This foundational course allows the student to apply knowledge of pathophysiology, pharmacokinetics, and pharmacodynamics to design, analyze and evaluate pharmacological treatment regimes informed by research evidence and best practice guidelines. This course is taught primarily online.

NUR 453. Pathophysiology and Psychopharmacology of Mental Health Disorders across the Lifespan II
Prerequisite: Matriculated into program and/or by permission of the instructor NUR 452: Pathophysiology and Psychopharmacology of Mental Health Disorders across the Lifespan I
Credit—three hours
Pathophysiology and Psychopharmacology of Mental Health Disorders across the Lifespan II offers an in-depth investigation of the neurobiological basis of major psychiatric illnesses for individuals across the lifespan. This foundational course allows the student to apply knowledge of pathophysiology, pharmacokinetics, and pharmacodynamics to design, analyze and evaluate pharmacological treatment regimes informed by research evidence and best practice guidelines. This course is taught primarily online.

NUR 454. Group and Family Psychotherapy Across the Lifespan
Prerequisite: Prerequisites: NUR450 Theories of Psychopathology, Mental Health Assessment and diagnosis across the lifespan
Credit—three hours
This course provides the theoretical basis for the understanding and implementation of group and family psychotherapy. Consumers will include the family as client as well as the group and/or family as the context of care for the individual client. Students will develop an advanced knowledge of current theories and practice modalities related to the practice of group and family psychotherapy and will develop the skills required of a psychiatric nurse practitioner.

NUR 455. Theoretical Frameworks for Advanced Psychiatric Nursing Practice
Credit—three hours
This is a foundational course that introduces students to theoretical frameworks that will be applied throughout their graduate coursework in psychiatric mental health nursing. Students develop an appreciation for the importance of theory and how it is applied in advanced psychiatric mental health nursing practice. Theories that explain personality development and human behavior, the etiology of psychopathology, and mechanisms of therapeutic change associated with major schools of psychotherapy are examined. Students gain experience in applying and analyzing theories based on research evidence and relevance to advanced practice psychiatric nursing.

NUR 456. Practicum in Advanced Family Psychiatric Mental Health Nurse Practitioner Role I
Prerequisite: NUR410/NUR 412 Advanced Health Assessment (pre-requisite) NUR450 Psychopathology and Psychiatric Assessment and Diagnosis Across the Lifespan (pre or co-req)
Credit—three hours ( three clinical )
This course provides students with a forum to synthesize knowledge acquired throughout the curriculum, and facilitates role and skill development for advanced family psychiatric mental health nursing practice with individuals across the lifespan and their families from diverse cultures. The purpose of this practicum is to equip students with the skills to enact the role of the FPMH Nurse Practitioner through the integration of content across the curriculum. Students apply knowledge of psychopathologies, differentiating normal from abnormal development and psycho-social functioning throughout the life span. Culturally sensitive approaches and knowledge of cultural diversity are applied in processes of assessment, differential diagnoses, psycho-education, and beginning treatment planning. Students recognize and intervene with clients and families with/ or at risk for common psychiatric emergencies, preserving their dignity and confidentiality. The importance of understanding one’s emotional responses to others is applied to processes of therapeutic relationship development. Clinical practicum seminars facilitate the integration of theory with clinical practice. Case presentations and role-plays are utilized as integral components of seminar discussions. Students will incorporate evidence-based resources in evaluating clinical performance and case presentations.

NUR 457. Practicum in Advanced Family Psychiatric Mental Health Nurse Practitioner Role II
Prerequisite: Matriculated into the Program NUR 460 pre-requisite NUR 463, NUR 471, NUR 477 pre or co-requisites
Credit—four hours ( four clinical )
This course provides students with a forum to synthesize knowledge acquired throughout the curriculum and facilitates role and skill development for advanced psychiatric mental health nursing practice with clients and their families. Students build on prior competencies while applying knowledge of psychotherapeutic modalities and psychopharmacology in comprehensive treatment planning for clients. Students recommend therapy models and psychopharmacological agents based on current evidence and practice guidelines. Students provide client and family psychoeducation regarding evidence-based treatments and partner with clients and families in treatment planning with sensitivity to cultural issues. Students integrate legal and ethical considerations in clinical decision making. Clinical practicum seminars facilitate the integration of theory with precepted clinical practice. Case presentations and role-plays are utilized as integral components of seminar discussions. Students incorporate
evidence-based resources in evaluating clinical performance and case presentations.

**NUR 458. Practicum in Advanced Family Psychiatric Mental Health Nurse Practitioner Role III**  
*Prerequisite: Pre-requisites: NUR 456 and 457*  
*Credit—four hours (four clinical)*

This course provides students with a forum to synthesize knowledge acquired throughout the curriculum and facilitates role and skill development for the advanced FPMH nursing practice for individuals across the lifespan and their families. Students build on prior life span competencies to include: applying family, systems, and organizational theories in facilitating team processes. Students will identify opportunities for interdisciplinary collaboration, referral and consultation; recognizing system issues; and identifying influences of organizational culture on quality of care. Students integrate legal and ethical considerations in clinical decision-making. Students explore the influence of public policy and develop plans for advocating for organizational and system change to promote quality outcomes within a continuum of mental health services. The seminar format will facilitate the integration of theory with precepted clinical practice. Case presentations and role-plays are utilized as integral components of seminar discussions. Students incorporate evidenced based resources in evaluating clinical performance and case presentation.

**LEADERSHIP IN HEALTH CARE SYSTEMS**

**Health Care Organization Management and Leadership Track**

**NLX 464. Informatics, Process Improvement, and Value in Health Care**  
*Credit—three hours*

This course prepares students for practice in organizations characterized by automation, performance improvement, outcome measurement and public transparency. Course content addresses information technology and application; work process design and improvement; and outcome targeting and measurement. Students meet with designated information technology professionals who demonstrate relevant computer applications and highlight their organizational value. They gain experience in linking organizational objectives to performance indicators and acquire skill in the design and implementation of models through which to evaluate outcomes against performance indicators. In addition, DNP students will work on quality improvement and population health analytics projects during the course of the semester.

**NLX 465. Master’s Capstone**  
*Credit—four hours (three didactic)*

This course is the summative course taken by CNL, HCM, and MNE students. During this final course, students conduct a clinical, organizational, or educational project that requires the synthesis and application of concepts, tools, and skills learned in the various courses during the student’s program. This executive-level project, which may be a program design or a program evaluation, is conducted under the direction of a preceptor and is intended to directly benefit an organization and a broader targeted community.

**NLX 466. Epidemiology**  
*Credit—three hours*

This course represents the research component of the Leadership in Health Care Systems Master’s Program and will prepare students with advanced research competencies. The course presents (a) the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs and services; and (b) the foundations of epidemiology and population-based practice. Emphasis is placed on application of epidemiological methods and strategies in the conduct and evaluation of population-based health research and outcomes. This course provides in-depth coverage of epidemiological principles and methods including natural history of disease, dynamics of disease etiology and transmission, measures of population morbidity and mortality, diagnostics and screening tests, risk exposure, population health disparities, structural and community-based interventions, health services evaluation, cost-effectiveness, and epidemiology and public policy.

**NLX 467. Population Health and Program Design**  
*Prerequisite: NLX 466 Epidemiology. This course is open to nonmatriculated students with permission of instructor.*  
*Credit—three hours*

The primary goal of this online course is to introduce students to the principles of health promotion and program design. Through integrating principles of population health, community collaboration and mobilization, behavior change, cultural competency, and program design, students will be able to design organizational, clinical and community health improvement programs. The content of this course addresses ethical considerations in population health and program design as well as provides the student with insight into important health issues driving organizational care delivery and problems facing local and national population groups. It also provides students with web-based access to many of the resources addressing population health. The primary focus of this course will be on health improvement at the organizational and community level, however, clinical prevention at the individual level will also be addressed.

**NLX 468. Program Evaluation**  
*Credit—three hours*

**NLX 470. Foundations of Leadership and Organizational Behavior**  
*Credit—four hours*

This course provides fundamental content in leadership and organizational behavior to assist students in individual leadership development and organizational awareness. Students explore leadership styles, behaviors and traits required to create and maintain high levels of individual and organizational performance. Leadership roles are examined from individual
and interpersonal, and ethical perspectives, with an emphasis on effective communication. This course also provides students with a philosophical and theoretical framework of leadership by examining historical and contemporary theories, models and leadership styles. Students explore leadership effectiveness and its relationship to issues of ethical decision-making, power, influence, persuasion, motivation, employee performance and ethical decision-making. The course utilizes a highly interactive, mixed-method format that examines concepts and builds skills through on-line and in-class discussions, problem-solving, case studies, and role-playing. Students also have the opportunity to meet with and observe current health care business leaders from a variety of organizations.

**NLX 471. Trends in Health Economics, Policy and Regulations**  
*Prerequisite: Introduction to Statistics — required Introductory Microeconomics - strongly recommended but not required*  
*Credit—four hours*

In this course, students examine major developments in the evolution, design, function, management, regulation and evaluation of national health policy and the health care system. They explore historical, social, political and economic trends in the evolution of the nation’s health delivery paradigm. Students analyze the impact of economic, political and regulatory forces on health care costs, access, quality and outcomes. Students discuss responses to economic incentives by the major players in the health care system: consumers, providers of services, insurers and payers. They also review the special role of the government in shaping the health care system. The students examine the nature of the country’s current health ‘crisis’ and assess major proposals for crisis abatement.

**NLX 473. Healthcare Financial Management**  
*Prerequisite: none*  
*Credit—three hours*

This foundational course provides health care managers the accounting and financial information needed to assure that organizations produce information that will support their responsibility to make necessary and sound decisions. The course will focus on the operations of health care organizations such as not for profit and for profit hospitals, physician groups and other healthcare agencies including how these organizations use accounting and financial systems for decision making. In this course, we will examine the healthcare organization as a management function and the basic principles of accounting followed by financial statement analyses, cost accounting, cost shifting, capital and operating budgeting, managing accounts receivable, materials management and healthcare economics. We will examine these topics and their use in planning, control, evaluation and “real life” work examples. The primary objective of this course will be to provide a fundamental comprehension of the tools needed to understand and communicate with accounting and financial peers within the workplace and profession and be able to be involved in a constructive manner in making sound managerial decisions. The healthcare system in the U.S. has been in the midst of a rapid transition in response to changing trends and demographics, technological advances and changing methods of reimbursement. The roles of care providers and administrators are complex and many times contradict each other when quality, cost efficiency and financial matters are discussed. As the U.S. moves toward a more consumer driven healthcare system and the numerous discussions currently in the political arena for an affordable healthcare system to include all Americans, it becomes a challenge for care providers, patients and administrators to balance the topics discussed in this class and eventually serve the patients in the best possible manner for the least amount of cost.

**NLX 474. Human Resource Management**  
*Credit—three hours*

This foundational human resource management course provides healthcare managers with the knowledge and skills necessary to ensure organizational success by recruiting and retaining talented, motivated employees. Students will explore best practices in critical performance management areas such as recruitment and retention, employment laws, affirmative action, team functioning, employee training, benefits and compensation and career management including coaching. This course provides the healthcare manager with current thinking, theory, and best practices for the effective management of people in health-care organizations.

**NLX 493. Comprehensive Exam**  
*Credit—none*

**Clinical Nurse Leader Track**

**NLX 421. Physiology, Pathophysiology, and Pharmacology for Nurse Leaders and Educators**  
*Prerequisite: Undergraduate anatomy and physiology*  
*Credit—four hours*

In this course students will explore physiological, pathophysiological, and pharmacologic processes to prepare nurses for roles in leadership and education. Students will learn key physiologic concepts of homeostasis, regulatory mechanisms, protein function, and cellular physiology. Students will then learn about pathophysiology and pharmacologic management of common diseases that occur in the major body systems. In this course students will explore physiological, pathophysiological, and pharmacologic processes to prepare nurses for roles in leadership and education. Students will learn key physiologic concepts of homeostasis, regulatory mechanisms, protein function, and cellular physiology. Students will then learn about pathophysiology and pharmacologic management of common diseases that occur in the major body systems.
NLX 422. Health Assessment for Nurse Leaders and Educators
Prerequisite: Undergraduate (UG) physical assessment course, such as NUR 362/364, or equivalent. If the UG physical assessment course was taken > 5 years ago, students will need NSG 363 &ndash; Comprehensive Health Assessment: Refresher.
Credit—four hours ( three didactic )

The course focuses on assessment of patients at an advanced level, building on undergraduate health assessment competencies, and provides the theoretical and clinical foundation for comprehensive assessment of the health status of individuals and families across the lifespan. Learners will also begin to explore teaching and supporting health assessment findings of undergraduate students and RNs in clinical practice. Building on undergraduate assessment preparation, principles of interviewing and history-taking, and advanced physical, psychosocial, cultural, developmental, and environmental assessments are presented. Strategies for health promotion are discussed and applied to clinical findings. The course includes supervised laboratory sessions for specialty skill practice and supervised teaching experiences for demonstration of skills and clinical teaching.

NLX 464. Informatics, Process Improvement, and Value in Health Care
Credit—three hours

This course prepares students for practice in organizations characterized by automation, performance improvement, outcome measurement and public transparency. Course content addresses information technology and application; work process design and improvement; and outcome targeting and measurement. Students meet with designated information technology professionals who demonstrate relevant computer applications and highlight their organizational value. They gain experience in linking organizational objectives to performance indicators and acquire skill in the design and implementation of models through which to evaluate outcomes against performance indicators. In addition, DNP students will work on quality improvement and population health analytics projects during the course of the semester.

NLX 465. Master’s Capstone
Credit—four hours ( three didactic )

This course is the summative course taken by CNL, HCM, and MNE students. During this final course, students conduct a clinical, organizational, or educational project that requires the synthesis and application of concepts, tools, and skills learned in the various courses during the student’s program. This executive-level project, which may be a program design or a program evaluation, is conducted under the direction of a preceptor and is intended to directly benefit an organization and a broader targeted community.

NLX 466. Epidemiology
Credit—three hours

This course represents the research component of the Leadership in Health Care Systems Master’s Program and will prepare students with advanced research competencies. The course presents (a) the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs and services; and (b) the foundations of epidemiology and population-based practice. Emphasis is placed on application of epidemiological methods and strategies in the conduct and evaluation of population-based health research and outcomes. This course provides in-depth coverage of epidemiological principles and methods including natural history of disease, dynamics of disease etiology and transmission, measures of population morbidity and mortality, diagnostics and screening tests, risk exposure, population health disparities, structural and community-based interventions, health services evaluation, cost-effectiveness, and epidemiology and public policy.

NLX 467. Population Health and Program Design
Prerequisite: NLX 466 Epidemiology. This course is open to nonmatriculated students with permission of instructor.
Credit—three hours

The primary goal of this online course is to introduce students to the principles of health promotion and program design. Through integrating principles of population health, community collaboration and mobilization, behavior change, cultural competency, and program design, students will be able to design organizational, clinical and community health improvement programs. The content of this course addresses ethical considerations in population health and program design as well as provides the student with insight into important health issues driving organizational care delivery and problems facing local and national population groups. It also provides students with web-based access to many of the resources addressing population health. The primary focus of this course will be on health improvement at the organizational and community level, however, clinical prevention at the individual level will also be addressed.

NLX 470. Foundations of Leadership and Organizational Behavior
Credit—four hours

This course provides fundamental content in leadership and organizational behavior to assist students in individual leadership development and organizational awareness. Students explore leadership styles, behaviors and traits required to create and maintain high levels of individual and organizational performance. Leadership roles are examined from individual and interpersonal, and ethical perspectives, with an emphasis on effective communication. This course also provides students with a philosophical and theoretical framework of leadership by examining historical and contemporary theories, models and leadership styles. Students explore leadership effectiveness and its relationship to issues of ethical decision-making, power, influence, persuasion, motivation, employee performance and ethical decision-making. The course utilizes a highly interactive,
mixed-method format that examines concepts and builds skills through on-line and in-class discussions, problem-solving, case studies, and role-playing. Students also have the opportunity to meet with and observe current health care business leaders from a variety of organizations.

**NLX 475. Leadership in Clinical nursing**  
*Credit—four hours (three didactic, one clinical)*

This course introduces students to the role and responsibilities of a clinical nurse leader (CNL). Leadership skills are discussed within the broader framework of system change and quality improvement. The emphasis is on working with interdisciplinary teams to create and shape effective health care delivery systems responsive to the needs of individuals and families.

**NLX 476. CNL Immersion Experience**  
*Prerequisite: NLX 475, or permission of the instructor. The course is not open to non-matriculated students.  
Credit—three hours (three clinical)*

Following successful completion of the formal clinical nurse leader (CNL) didactic/role synthesis course, this field immersion course provides the student with an opportunity to implement CNL clinical leadership practice in the context of complex micro-, meso-, and macro-level system relationships in a chosen healthcare setting. Through a variety of leadership experiences, precepted by an experienced CNL or other health system leader (e.g., advanced practice nurse, nurse educator, division director) in daily practice, the student is exposed to, observes, interacts, and collaborates with staff, interprofessional teams, leaders, patients, and family members across system levels and organizational boundaries throughout the processes of health care delivery. Any form of nursing or system intervention that influences healthcare outcomes for individuals or populations, including the direct care of individual patients, management of care for individuals and populations, redesign of care environments, administration of nursing and the healthcare organization, and the development and implementation of health policy are relevant experiences for the CNL student.

**MASTER’S OF NURSING EDUCATION**

**EDU 497. Teaching & Learning in Higher Education**  
*Credit—three hours*

A study of theory-based effective teaching, learning, and assessment practices for use in higher education and learning organizations. Stresses teaching, learning, and assessment practices that facilitate meaningful learning. Designed to meet the diverse needs and interests of a broad range of graduate students, teachers, and working professionals interested or currently working in higher education or learning organizations.

**EDU 580. Foundations of Health Professions Education**  
*Credit—three hours*

A foundational study of the historical, scientific, social, and political roots of health professions education, educational theory, and the continuum of this education. Provides the contextual framework for education in the health professions and emphasizes the historical and sociological theory of the evolution of this education. Critically examines the roles and responsibilities in the assessment and certification of graduates, as well as discusses the framework for accreditation and licensing of health care professionals. Current program assessment methods and tools are reviewed, as well as ethics and responsibilities of education leaders in different roles.

**EDU 581. Clinical Teaching in Health Care Professions Education: Teaching and Instructional Methods**  
*Credit—four hours*

Presents traditional and innovative methods used in clinical teaching to enhance student and practitioner knowledge, skills, and attitudes, and critically examines the theories behind different teaching methodologies. Discusses current and potential future uses of technology in active learning strategies in the clinical environment will be discussed. Also explores ethical and patient safety issues.

**NLX 421. Physiology, Pathophysiology, and Pharmacology for Nurse Leaders and Educators**  
*Prerequisite: Undergraduate anatomy and physiology  
Credit—four hours*

In this course students will explore physiological, pathophysiological, and pharmacologic processes to prepare nurses for roles in leadership and education. Students will learn key physiologic concepts of homeostasis, regulatory mechanisms, protein function, and cellular physiology. Students will then learn about pathophysiology and pharmacologic management of common diseases that occur in the major body systems. In this course students will explore physiological, pathophysiological, and pharmacologic processes to prepare nurses for roles in leadership and education. Students will learn key physiologic concepts of homeostasis, regulatory mechanisms, protein function, and cellular physiology. Students will then learn about pathophysiology and pharmacologic management of common diseases that occur in the major body systems.
NLX 422. Health Assessment for Nurse Leaders and Educators
Prerequisite: Undergraduate (UG) physical assessment course, such as NUR 362/364, or equivalent. If the UG physical assessment course was taken &gt; 5 years ago, students will need NSG 363 &ndash; Comprehensive Health Assessment: Refresher. Credit—two hours (one didactic, one lab)

The course focuses on assessment of patients at an advanced level, building on undergraduate health assessment competencies, and provides the theoretical and clinical foundation for comprehensive assessment of the health status of individuals and families across the lifespan. Learners will also begin to explore teaching and supporting health assessment findings of undergraduate students and RNs in clinical practice. Building on undergraduate assessment preparation, principles of interviewing and history-taking, and advanced physical, psychosocial, cultural, developmental, and environmental assessments are presented. Strategies for health promotion are discussed and applied to clinical findings. The course includes supervised laboratory sessions for specialty skill practice and supervised teaching experiences for demonstration of skills and clinical teaching.

NLX 426. Curriculum Development and Course Design
Credit—four hours (three didactic, one clinical)

In this course students will learn how to design, evaluate, and revise curricula and courses using a variety of theories and methods. Students will also learn to apply leadership and organizational change theories to implement curricular change. Students will explore the relationships between curriculum development, program evaluation, and accreditation.

NLX 427. Assessment and Evaluation in Nursing Education
Credit—four hours (three didactic, one clinical)

This course will provide students with the opportunity to design, interpret, and evaluate student learning in clinical and academic settings. Students will learn assessment methods appropriate to different settings encountered by nurse educators, including the classroom, clinical settings, and online. Students will learn to evaluate assessment measures using a variety of psychometric tests. Current, ethical, legal and social/policy implications of assessment will be explored. Students will also analyze the role of assessment in program evaluation and accreditation.

NLX 465. Master’s Capstone
Credit—three hours (three didactic)

This course is the summative course taken by CNL, HCM, and MNE students. During this final course, students conduct a clinical, organizational, or educational project that requires the synthesis and application of concepts, tools, and skills learned in the various courses during the program. This executive-level project, which may be a program design or a program evaluation, is conducted under the direction of a preceptor and is intended to directly benefit an organization and a broader targeted community.

NLX 493. Comprehensive Exam
Credit—none

NUR 000. Nursing Elective
Credit—three hours

DOCTOR OF NURSING PRACTICE (DNP) PROGRAM

NLX 464. Informatics, Process Improvement, and Value in Health Care
Credit—four hours

This course prepares students for practice in organizations characterized by automation, performance improvement, outcome measurement and public transparency. Course content addresses information technology and application; work process design and improvement; and outcome targeting and measurement. Students meet with designated information technology professionals who demonstrate relevant computer applications and highlight their organizational value. They gain experience in linking organizational objectives to performance indicators and acquire skill in the design and implementation of models through which to evaluate outcomes against performance indicators. In addition, DNP students will work on quality improvement and population health analytics projects during the course of the semester.

NLX 466. Epidemiology
Credit—three hours

This course represents the research component of the Leadership in Health Care Systems Master’s Program and will prepare students with advanced research competencies. The course presents (a) the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs and services; and (b) the foundations of epidemiology and population-based practice. Emphasis is placed on application of epidemiological methods and strategies in the conduct and evaluation of population-based health research and outcomes. This course provides in-depth coverage of epidemiological principles and methods including natural history of disease, dynamics of disease etiology and transmission, measures of population morbidity and mortality, diagnostics and screening tests, risk exposure, population health disparities, structural and community-based interventions, health services evaluation, cost-effectiveness, and epidemiology and public policy.

NLX 470. Foundations of Leadership and Organizational Behavior
Credit—four hours

This course provides fundamental content in leadership and organizational behavior to assist students in individual leadership development and organizational awareness. Students explore leadership styles, behaviors and traits required to create and maintain high levels of individual and organizational performance. Leadership roles are examined from individual and interpersonal, and ethical perspectives, with an emphasis on effective communication. This course also provides students
with a philosophical and theoretical framework of leadership by examining historical and contemporary theories, models and leadership styles. Students explore leadership effectiveness and its relationship to issues of ethical decision-making, power, influence, persuasion, motivation, employee performance and ethical decision-making. The course utilizes a highly interactive, mixed-method format that examines concepts and builds skills through on-line and in-class discussions, problem-solving, case studies, and role-playing. Students also have the opportunity to meet with and observe current health care business leaders from a variety of organizations.

**NUR 571. Trends in Health Economics, Policy and Regulations**
Prerequisite: Introduction to Statistics — required Introductory Microeconomics - strongly recommended but not required
Credit—four hours

In this course, students examine major developments in the evolution, design, function, management, regulation and evaluation of national health policy and the health care system. They explore historical, social, political and economic trends in the evolution of the nation’s health delivery paradigm. Students analyze the impact of economic, political and regulatory forces on health care costs, access, quality and outcomes. Students discuss responses to economic incentives by the major players in the health care system: consumers, providers of services, insurers and payers. They also review the special role of the government in shaping the health care system. The students examine the nature of the country’s current health ‘crisis’ and assess major proposals for crisis abatement.

**NUR 509. Managing and Analyzing Data**
Credit—three hours

**NUR 570. Clinical and Translational Research Design**
Prerequisite: Introductory Statistics (Nursing 510 or equivalent)
Credit—four hours

This course covers basic principles of research design as well as ethical considerations in conducting research with human subjects. A variety of designs will be reviewed including randomized clinical trials, quasi-experimental designs, cohort (prospective and retrospective), factorial, cross-over and case-control. In addition, community participatory research and translational models will be examined. Requirements and design elements to maintain scientific rigor and study integrity, specifically internal and external validity, construct and statistical conclusion validity are integral components of the course. Statistical methods for these study designs will be reviewed.

**NUR 572. Appraisal and Application of Evidence in Healthcare**
Credit—three hours

This course will prepare students to evaluate evidence in order to improve clinical outcomes and to translate that evidence into the practice setting. Methodologies to appraise the hierarchy of clinical research will be examined. Integration of evidence-based decision making into scholarly practice will also be explored.

**NUR 573. Interprofessional Partnerships**
Prerequisite: None for matriculated students, but course content preceding NUR 573 in the part-time DNP program sequence contains important background material.
Credit—three hours

This course is designed to strengthen students’ knowledge and skills in designing, implementing, and evaluating the effects of interprofessional approaches on the health care “team”/micr-system, organizational, and community performance. Students participate in experiential learning activities and synthesize information from a broad interdisciplinary literature base to assess and evaluate challenges and facilitators to interprofessional approaches for person-centered care. The types of educational activities and interventions designed to improve such approaches are explored and analyzed. Students are expected to examine their experiences as interprofessional team members critically and, as leaders in their clinical practice settings and propose interventions to improve person-centered outcomes.

**NUR 574. Strategic Planning in Healthcare Organizations**
Prerequisite: NUR 570 Clinical and Translational Research Design; NUR 510 Applied Statistics I; NUR 572 Appraisal and Application of Evidence in Healthcare. This course is open to students matriculated into the Doctor of Nursing Practice (DNP) program and others with permission from the instructor.
Credit—three hours

In this course, various theoretical approaches related to organizational and systems change are examined. Applied research and theory-derived evaluation methods are used to explore student-identified questions of relevance to health delivery systems. Students will learn the skills necessary for assessing the organization, measuring and monitoring outcomes of individuals and organizations within diverse healthcare systems.

**NUR 575. Health Policy Development and Political Change**
Credit—three hours

This course provides students with direct exposure to public and private sector roles in health policy development and experience advising policy makers about health care issues. It promotes critical thinking, leadership, and advocacy skills required to initiate health policy development and change in a variety of health care settings.

**NUR 576. DNP Practicum I**
Prerequisite: NUR 572, NUR 574, NUR 510, NUR 570 (formerly NLX 480), NLX 464, successful completion of Master’s comprehensive exam, or by permission by course faculty.
Credit—three hours (one didactic, two clinical)

This first practicum course provides students with learning experiences to develop an independent capstone project within the student’s identified area of specialization. Such experiences are intended to support the analysis, integration, application and evaluation of knowledge gained through foundational coursework framed by the DNP Essentials as well as promote the development of clinical scholarship. Students explore best practice approaches as well as the theoretical and scientific foundation for practice.
NUR 577. DNP Practicum II
Prerequisite: NUR 576
Credit—three hours (one didactic, two clinical)
In this second practicum course, application and integration of knowledge gained through foundational coursework framed by the DNP Essentials continues. Students design a scholarly capstone project in an identified area of practice to optimize health care system functioning or care delivery. Students develop theoretically-based, methodologically-sound initiatives which improve practice and/or patient care. Following completion of this course, students will be prepared to complete their qualifying exam and defend their capstone project proposal as well as submit their proposal for human subject protection approval.

NUR 578. DNP Practicum III
Prerequisite: NUR 576, NUR 577
Credit—variable hours
This course builds on DNP Practicum II and is usually completed over three semesters. Application and integration of knowledge gained through foundational coursework framed by the DNP Essentials continues with the implementation of a scholarly capstone project over several semesters in an identified area of practice which has the potential to optimize healthcare system functioning or care delivery. Students are guided through implementation of theoretically-based, methodologically-sound initiatives which improve practice and/or patient care. Following completion of this course, students will be prepared to defend their final capstone project as well as disseminate project findings.

PhD PROGRAM

IND 501. Ethics and Professional Integrity Clinical Research
Credit—one hour
This course is required of all graduate students in the biomedical sciences in the School of Medicine and Dentistry. The course features seven modules that provide information about the various topics that the National Institutes for Health consider essential to understanding the responsible conduct of research including human experimentation/conflict of interest, animal experimentation, stem cell research, mentor-student relationship, plagiarism/scientific misconduct, collaborative science, and publication/copyright. The course is offered in a lecture/case study and small discussion group format.

NSG XXX. Nursing Elective
Credit—none

NUR 505. Epistemology and Concept Development
Prerequisite: PhD and MS-Ph.D. students in Health Practice Research or instructor permission.
Credit—three hours
This course examines the various epistemological debates about science in current health care literature. These debates reflect different ways of knowing and arise out of different philosophical traditions, such as rationalism, empiricism, historicism, and organismism. An understanding of these debates informs the discussion about the nature of science and theory. Different approaches to concept development are explored in the context of their philosophical foundations. Students will apply the process of concept development to a specific area of interest.

NUR 506. Epistemology and Theory Construction
Prerequisite: Ph.D. and MS-Ph.D. students in Health Practice Research, or instructor permission.
Credit—three hours
This course examines epistemology debates about science in current health care literature. The debates reflect different ways of knowing and arise out of different philosophical traditions such as pragmatism, phenomenology, hermeneutics, post-structuralism and critical theory. An understanding about these debates informs the discussion about the nature of science and methodological approaches to generating knowledge in health care science. The process of theory construction is examined from logical, inductive and deductive approaches. The interrelationship between concepts, constructs and variables are explicated for considering how study designs are generated. Students will apply knowledge gained about the process of theory construction to a specific area of interest.
NUR 507. Research Appraisal and Synthesis
Prerequisite: To be taken concurrently with or sequential to NUR 510 Applied Statistics I and NUR 511 Basic Principles of Quantitative Research Design, or with permission of instructor.
Credit—three hours
This course is designed to prepare students to collect, appraise, and synthesize published research. It includes an introduction to library skills needed for the development of a literature review.

NUR 508. Writing and Publishing in the Health Sciences
Prerequisite: Matriculation in SON Ph.D. program; completion of NUR 507 or permission of instructor
Credit—two hours
The primary goal of this course is to prepare students to write publication-quality articles for peer-reviewed scientific journals. This course will provide students with both scholarly and practical knowledge about writing and publishing scientific manuscripts. It will cover the publishing process as well as techniques for writing clear and well-organized manuscripts and ethical issues involving manuscript preparation and publication.

NUR 510. Applied Statistics I
Credit—three hours
This course provides an introduction to descriptive and inferential statistics and the use of the SPSS data management and analysis package. Topics include creating and managing a research data file, generating descriptive statistics and performing and interpreting several data analytic strategies, including analysis of variance, correlation and regression and non-parametric statistics.

NUR 511. Basic Principles of Quantitative Research Design
Prerequisite: PhD and MS-PhD students in Health Practice Research or permission of instructor
Credit—three hours
This course covers basic principles of quantitative research design with human subjects. The topics covered include the analysis of causal relationships; threats to internal and external validity; experimental, quasi-experimental, relational, and descriptive designs, and case control and cohort study designs. Students will be introduced to designing an a priori analytic plan for the various types of studies.

NUR 512. Applied Statistics II
Prerequisite: NUR 510: Applied Statistics I or permission of instructor.
Credit—three hours
This course presents intermediate and advanced techniques for the statistical analysis of multiple quantitative variables. These techniques are particularly applicable to the complex research designs characteristic of studies of nursing problems and other health science questions. Building on Applied Statistics I, topics include data cleaning, multiple linear and nonlinear regression, and process analysis. The course includes both theory and practice components, with an emphasis on interpretation of statistical results.

NUR 513. Research Measurement
Prerequisite: NUR 505, 506, 507, 510, 511, and 512
Credit—three hours
The emphasis of the course is on the principles of measurement and their application to problems in health research. The course will address (a) the theoretical and conceptual underpinnings of measurement, (b) operational and practical issues of translating theoretical constructs to empirical measures, (c) quantitative approaches to assessing and validating research measures, and (d) application of measures in relevant study designs. The course is thus designed to cover conceptual, methodological and substantive areas of research measurement, with an emphasis on critical thinking, problem solving, and hands-on application.

NUR 514. Research Integration and Proposal Development
Prerequisite: Successful completion of the PhD Qualifying Examination
Credit—three hours
The course will provide students an opportunity to integrate material from courses in cognate areas, research methods, statistics, and clinical research against the context of environmental, professional, and ethical realities. Issues examined include protection of and access to human participants for research, collaborative roles, research funding, and publication. Learning experiences include examination of published research and reviews of research in the student’s area of interest, presentations of preliminary plans for a research project, preparation of a formal written research proposal, and peer review of a student colleague’s research proposal.

NUR 555. Basic Principles of Qualitative Research Methods
Prerequisite: PhD and MS-PhD students in Health Practice Research or permission of instructor
Credit—three hours
This course introduces the student to the field of qualitative research and covers basic principles of research design with an emphasis on the appropriate use of methods. The primary focus is on methods that are common to the design, conduct, and reporting of qualitative research across genres. Attention also is given to the different purposes and approaches of specific genres through readings and examples of work, such as qualitative/interpretive description, narrative and arts-informed studies, critical inquiry, participatory action research (PAR), and approaches to research within the traditions of ethnography, grounded theory, and phenomenology.

NUR 560. Role of the Clinical Researcher
Credit—none
Drawing on presentations from faculty researchers associated with the School of Nursing, students are provided with the opportunity to consider their future career trajectories. Presenters will discuss the interplay between clinical practice questions and the research approaches being used to address these knowledge needs. Presentations are designed to help students to conceptualize their own research questions.
**NUR 590. Dissertation Workshop**  
*Prerequisite: Completion of all coursework in the PhD Program  
*Credit—none*

The purpose of the Dissertation Workshop is to help students who have completed their coursework to sustain momentum toward proposal defense and completion of the doctoral program requirements. It provides a regular, organized opportunity to present work in progress on the dissertation proposal and to receive feedback from faculty and fellow doctoral students. Research topics relevant to students’ ongoing research are identified and discussed.

**NUR 595. PhD Research**  
*Credit—variable hours*

Varies based on independent research

**NUR 995. Continuation of Doctoral Enrollment**  
*Credit—none*

Continuation of Doctoral Enrollment program extension granted

**NUR 999. Doctoral Dissertation**  
*Credit—none*

Doctoral Dissertation varies based on independent research

For further information, contact:  
Office of Student Affairs  
University of Rochester School of Nursing  
601 Elmwood Avenue, Box SON  
Rochester, New York 14642-0001  
(585) 275-2375
Administrative Officers

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David Tilson, PhD
Associate Dean of the Full-Time MBA Program

Full-Time Faculty

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Professor of Marketing

James A. Brickley, PhD (Oregon)
Gleason Professor of Business Administration and Professor of Economics and Management

Delores Conway, PhD (Stanford)
Professor of Statistics and of Real Estate Economics

Rajiv M. Dewan, PhD (Rochester)
Xerox Professor of Computers and Information Systems and Operations Management

Paul Ellickson, PhD (MIT)
Michael and Diane Jones Professor and Professor of Economics and Management and of Marketing

Ronald L. Goettler, PhD (Yale)
James N. Doyle, Sr. Professor in Entrepreneurship and Professor of Economics and of Marketing

Gregg A. Jarrell, PhD (Chicago)
Professor of Finance and Economics

Ron Kaniel, PhD (Pennsylvania)
Jay S. and Jeanne P. Benet Professor of Finance

Robert Novy-Marx, PhD (California, Berkeley)
Lori and Alan S. Zilkelman Distinguished Professor of Business Administration and Professor of Finance

G. William Schwert, PhD (Chicago)
Distinguished University Professor of Finance and Statistics

Abraham Seidmann, PhD (Texas Tech)
Xerox Professor of Computers and Information Systems and Operations Management

Greg Shaffer, PhD (Princeton)
Wesray Professor for Entrepreneurial Study and Professor of Economics and Management and of Marketing

Clifford W. Smith, Jr, PhD (North Carolina, Chapel Hill)
Louise and Henry Epstein Professor of Business Administration and Professor of Finance and Economics

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Fred H. Gowen Professor of Finance

Charles E. Wasley, PhD (Iowa)
Professor of Accounting

Joanna Shuang Wu, PhD (Tulane)
Susanna and Evans Y. Lam Professor of Accounting

Abraham Seidmann, PhD (Texas Tech)
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Harry Groenevelt, PhD (Columbia)
Associate Professor of Operations Management

Sudarshan Jayaraman, PhD (North Carolina, Chapel Hill)
Associate Professor of Accounting

Phillip J. Lederer, PhD (Northwestern)
Associate Professor of Operations Management

Mitchell J. Lovett, PhD (Duke)
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Jeanine Miklós-Thal, PhD (Toulouse 1)
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Michael A. Raith, PhD (London School of Economics and Political Science)
Associate Professor of Economics and Management

Vera Tilson, PhD (Case Western Reserve)
Associate Professor of Operations Management

Gerard J. Wedig, PhD (Harvard)
Associate Professor of Business Administration
ASSISTANT PROFESSOR

Guy Arie, PhD (Northwestern)
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Erin Smith, PhD (New York University)
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Giulio Trigilia, PhD (Warwick University)
Assistant Professor of Finance

Jason Liang Xiao, PhD (Pennsylvania)
Assistant Professor of Accounting

Chenyu Yang, PhD (Tel Aviv)
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Pavel Zryumov, PhD (Stanford)
Assistant Professor of Finance

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Ravi Mantena, PhD (New York University)
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Andras Miklós, PhD (Central European)
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Derek Mohr, JD (Case Western Reserve)
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Paul E. Nelson, PhD (Rochester)
Clinical Professor of Marketing

Thomas Shaw, MFA (Emerson)
Clinical Associate Professor of Business Administration

Carol Shuherk, PhD (Oregon)
Clinical Assistant Professor of Business Administration

David Tilson, PhD (Case Western Reserve)
Clinical Associate Professor of Computers and Information Systems

Heidi Tribunella, MS (SUNY Institute of Technology)
Clinical Associate Professor of Accounting

EXECUTIVE PROFESSOR

Richard Couch, MBA (Rochester)
Executive Professor of Finance

David J. Oliveira, MBA (Rochester)
Executive Professor of Business Administration

John Schloff, MBA (Pepperdine)
Executive Professor of Marketing

Full-Time MBA Program

To earn the Master of Business Administration degree, a student must complete 67 credit hours of study with a minimum 3.0 grade point average.

Much of the academic work in the MBA program will rely on computer-based analysis and computer-assisted presentations. Upon entry to the program, faculty will expect students to have a working knowledge of spreadsheet and word-processing software. The programs most widely used are Microsoft Excel and Access.

Full-Time Master of Science in Accountancy

To earn the Master of Science in Accountancy, students take nine required courses, two electives, and the MGC course sequence. A minimum 3.0 grade point average is required for graduation.

Assuming that students have met certain undergraduate prerequisite requirements, this program has been designated by the New York State Education Department as fulfilling the 150 credit-hour requirements for professional education programs in public accountancy.

Students whose undergraduate programs do not satisfy all the assumed prerequisites will be advised of the additional courses that they must complete following a review of their undergraduate transcript. The New York State Education Department will have final approval upon application for licensure.
Full-Time Master of Science in Finance

The program of study for the Master of Science in Finance degree has been designated as a lock-step program which meets all the requirements for a STEM-certified program. Students take 11 required courses, two electives, and the MGC course sequence. A minimum 3.0 grade point average is required for graduation.

Full-Time Master of Science in Marketing Analytics

Simon Business School's Master of Science in Marketing Analytics is designed to equip students with the skills and experience necessary to excel in marketing jobs in a compact, highly focused program. Students are likely to take a job related to one of the program's four main emphases: marketing research, consumer insights, advertising, and account management. To earn the Master of Science in Marketing Analytics degree, students take nine required courses, three electives, and the MGC course sequence. A minimum 3.0 grade point average is required for graduation.

Full-Time Master of Science in Business Analytics

The MS in Business Analytics combines business frameworks with the latest data analytics techniques to provide students with skills and concepts to deal with big data in organizations. Students learn concepts for dealing with large volumes, real-time, and unstructured data from organizational, web, and social sources. Economics, statistics, and elements from computer science form the foundation of the program.

To earn the Master of Science in Business Analytics degree, students take 10 required courses, three electives, and the MGC course sequence. A minimum 3.0 grade point average is required for graduation.

Professional MBA (PMBA) Program

To earn the Master of Business Administration degree, students in the Simon Business School's PMBA program take nine core courses and 11 electives with a minimum 3.0 grade point average to complete the degree. Although not required, students may complete a concentration. Most opt for at least one and, in many cases, two.

Part-Time Master of Science in Business Administration with a Concentration in Medical Management

Management Tools

The Simon Business School offers a part-time MS program in Medical Management to provide physicians, hospital administrators, and medical professionals with management tools and an understanding of the key business issues that confront health care providers. The part-time structure of the program allows health care professionals to maintain their career and personal commitments while in the program. The program focuses on developing health care managers and leaders who will be confident in making key financial, operational, and strategic decisions for their organizations.

Logistics and Time Requirements

The medical management program is specifically designed to accommodate the busy schedules of physicians and medical professionals. The program consists of 30 credits and is offered on a part-time basis only.

During a typical school quarter, the medical management student enrolls in a core class that meets one night per week. During the same quarter, the student also takes a class on three separate weekends to cover the health care component of the module.

The curriculum is presented in a unique format that delivers the necessary depth of core business material while simultaneously applying that material to the health care industry. This is accomplished through the pairing of the Simon School's core courses with health care management courses that develop applications of the core material. Each pair of courses (module) is delivered and taken simultaneously.

Business Systems Consulting

Simon School's concentration in Business Systems Consulting offers a cutting-edge, highly focused program designed to equip students with the skills and experience necessary to excel in the business systems consulting enterprise. While students will be exposed to a variety of career possibilities during the course of their studies, most students are likely to assume a position in the business systems practice of one of the major consulting firms.

Competitive and Organizational Strategy (STR) Track

The Simon Business School offers two tracks within the Competitive and Organizational Strategy (STR) concentration—the Strategy and Organizations track and the Pricing track. Students can choose either of these two tracks to satisfy the requirements of the Competitive and Organizational Strategy concentration.

Strategy and Organizations Track

The Strategy and Organizations track builds on the economic fundamentals introduced in STR 401 and STR 403. Its cross-functional and integrative curriculum provides a sound basis for the evaluation and implementation of a broad range of business strategies and policies. Topics included are policies internal to the firm such as compensation, performance evaluation, job design, and aspects of hiring; strategic interaction among industry competitors, including pricing and advertising; and the influence of external factors such as the regulatory and macroeconomic environments.

Skills offered by the STR curriculum develop the student's ability to identify the root causes of business problems and sources of new opportunities. The student responds to these problems and opportunities with innovative solutions and strategies based upon the school's economics-based approach to management. The concentration holds particular interest
to those seeking careers in consulting, general management, or industry analysis, as well as those seeking an integrative complement to concentrations in other functional areas. Particular emphasis goes to developing the student’s capacity to deal with unstructured business situations.

**Pricing Track**
The Pricing track is offered for those students who desire state-of-the-art training in pricing and for those interested in pursuing a career in pricing. The track resides within both the Competitive and Organizational Strategy and the Marketing concentrations and leverages our school’s strengths in economics and marketing analytics.

The Pricing track is offered by the Competitive and Organizational Strategy and Marketing faculty at the Simon School to enable students to integrate their knowledge of analytic marketing, cost accounting, finance, managerial economics, operations, and strategy through the application of pricing optimization tools and technologies to deliver profitable pricing strategies for their organizations.

**Computers and Information Systems (CIS)**
The Computers and Information Systems area enjoys international recognition for its innovative research and teaching programs. The CIS concentration, taken by itself or combined with another functional concentration such as accounting, finance, or operations management, prepares students to manage the broad array of information-systems issues that arise in every organization or to act as successful management consultants.

The concentration focuses on the leading approaches used in the design and development of effective business processes that leverage information technology. It also emphasizes the major business issues that arise in choosing information technologies, designing information processes for improving the effectiveness of specific applications, and using enterprise information technology for gaining competitive benefits. The concentration develops the necessary skills for managing in the current environment of rapid technological evolution, increased competition, and global markets. The placement of Simon School CIS students in retail or investment banks, Fortune 500 manufacturers, and international consulting companies has been very strong. Typical CIS careers include electronic commerce leadership, the management of corporate information systems, business process re-engineering, and general management consulting.

In the required courses, students learn how to analyze the fundamental subjects of business information and decision processes in organizations and the resulting economic and technological trade-offs. In the advanced electives, students study various aspects of electronic commerce, business process design, advanced information technologies, financial-information systems, and business data communications systems.

A technical background prior to entering the MBA program is not a prerequisite to success in the CIS concentration.

**Corporate Accounting (ACC)**
Corporations actively recruit MBA accounting majors for positions in the offices of controller, treasurer, and internal auditing, as well as in accounting departments. Many corporate finance positions also require strong corporate accounting backgrounds.

**Entrepreneurship (ENT)**
Entrepreneurship education is becoming increasingly important given the current global economic climate. The Entrepreneurship concentration allows students to draw from a variety of carefully selected courses to become a business generalist, well versed in organizing and managing resources. Simon School has a legacy of educating entrepreneurs. Graduates with this concentration have started their own ventures or have pursued “intrapreneurial” careers with major corporations. Students often combine this concentration with finance or marketing to further enhance their education. This is especially true for those pursuing investment banking and mergers and acquisitions where the entrepreneurship knowledge is very useful.

**Finance (FIN)**
Simon School is best known for its research and scholarship in the area of finance. This concentration provides students with state-of-the-art techniques for financial analysis. Students learn to formulate and solve important corporate finance problems and to obtain information from the many databases on financial markets.

**Health Sciences Management (HSM)**
The Health Sciences Management concentration draws on the school’s proven strengths and directs them to a dynamic industry. This concentration focuses primarily on two management issues: ongoing operations and strategic planning. This is in contrast to the traditional Master of Public Health programs, which generally focus on public policy issues. The program especially suits future health sciences consultants and front-line managers in health maintenance organizations, hospitals, insurance companies, and pharmaceutical firms.

**International Management**
The International Management concentration gives students opportunities to apply various disciplines to international markets. Differences in legal environments, currencies, and workplace practices among countries provide both challenges and problems for businesses operating in the global marketplace.

One of two options will satisfy the concentration. The International Management option includes one required course and three electives. The International Management Exchange option includes one required course, one elective and one term (minimum of 6 credits) in an approved International Exchange Program.

**Marketing (MKT)**
Marketing knowledge and skills have become a necessity in today’s increasingly competitive global business environment. Regardless of the kind of business—consumer goods or industrial goods, financial services, or the nonprofit sector—success depends on satisfying the customer better than one’s competitors.
The Marketing concentration prepares MBA students for these challenges. Alumni with Marketing concentrations now hold key positions in marketing management, research, and consulting. Specialized programs are offered to students interested in brand management. In addition, many students combine marketing with another discipline to round out their education. Popular combinations include marketing/finance, marketing/operations management, and marketing/electronic commerce.

The Marketing curriculum emphasizes the integration of applications with theory. Applications are introduced via cases, experiential exercises, guest speakers, and projects. Elective courses provide opportunities to pursue specific interests in marketing.

The Marketing concentration requirements consist of the required core courses and electives chosen to satisfy the additional requirements of one of the following three tracks—the Marketing Strategy track, the Brand Management track, or the Pricing track—specified below.

**Marketing Strategy Track**
The Marketing Strategy track emphasizes the use of marketing principles for developing and implementing a firm’s product-market strategies in the marketplace.

**Brand Management Track**
For those students wishing to become brand/product managers in either the consumer or industrial products markets or in financial services, a unique Brand Management track is offered.

**Pricing Track**
The Pricing track is offered for those students who desire a state-of-the-art training in pricing and for those interested in pursuing a career in pricing. The track resides within both the Competitive and Organizational Strategy and the Marketing concentrations and leverages our school’s strengths in economics and marketing analytics.

The Pricing track is offered by the Competitive and Organizational Strategy and Marketing faculty at the school to enable students to integrate their knowledge of analytic marketing, cost accounting, finance, managerial economics, operations, and strategy through the application of pricing optimization tools and technologies to deliver profitable pricing strategies for their organizations.

**Operations Management**
Operations Management is concerned with the management of a firm’s physical, financial, and human resources with the objective of producing, distributing, and selling goods and services. Operations Management has become increasingly important due to renewed interest in productivity and the utilization of operations for competitive advantage.

**Public Accounting (CPA)**
The Public Accounting concentration offers courses needed toward the requirements for the Uniform Certified Public Accounting (CPA) examination in New York and other states. Assuming that students have met certain undergraduate prerequisite requirements, this program has been designated by the New York State Education Department as fulfilling the 150 credit-hour requirements for professional education programs in public accountancy. Students whose undergraduate programs do not satisfy all the assumed prerequisites will be advised of the additional courses that they must complete following a review of their undergraduate transcript. Students interested in completing this concentration should contact Heidi Tribunella, clinical associate professor of accounting, for a transcript review and academic advisement. The New York State Department of Education will have final approval upon application for licensure.

**Joint and Specialized Degree Programs**
Simon School offers programs that allow students to receive a first-rate business education tailored to their specific needs. In addition to the full- and part-time MBA programs, a few other opportunities are available to students who wish to pursue coursework within a more specialized context of business management.

The following is a list of the Joint and Specialized Degree Programs offered at the Simon School. Each specific entry includes a brief program description and contact details for further information.

**MD/MBA Program**
Along with the Simon School, the School of Medicine and Dentistry offers a combined MD/MBA degree program in Health Sciences Management. This program is designed to prepare physician managers who can respond intelligently, effectively, and creatively to the changing health care services industry. Only candidates with exceptional promise and academic records will be considered.

To participate in this program, students must apply to, and be accepted by both the School of Medicine and Dentistry and the Simon Business School. Students are also required to take both the MCAT and GMAT exams. The program takes five years to complete—taken separately, the MD is four years and the MBA is two years. Students start the program at the Simon School for the first-year core courses and the majority of electives, and then move to the MD program on a full-time basis, completing the remaining Simon School electives in their third and fourth years of medical school.

For application information, contact the director of admissions in the School of Medicine and Dentistry or the director of admissions in the Simon Business School.

**The 3-2 Program**
In this program, students earn both a bachelor’s degree in an undergraduate major from the University of Rochester and a Master of Business Administration degree in five years.

In three years of undergraduate study at the University, students complete their majors and distribution requirements. Between January and March of their junior year, qualified students apply to the Simon School. The first year of the MBA program is substituted for the senior year. No merit-based scholarships are available to 3-2 students. However, during the final year as an undergraduate, students maintain any undergraduate financial
assistance that is offered by the University of Rochester undergraduate College. Visit www.simon.rochester.edu/applynow for application details.

**Technical Entrepreneurship and Management (TEAM) MS Program**
The one-year TEAM master’s degree program is offered jointly by the Simon School and the Hajim School of Engineering & Applied Sciences and is administered by the University of Rochester Center for Entrepreneurship. This program is designed for students with an engineering, science, or mathematics undergraduate degree, who wish to pursue a master’s level technical education in combination with business and leadership courses. TEAM could also be considered a 4-1 program for University of Rochester undergraduate engineering students.

Students accepted into the TEAM program may choose any technical cluster, such as optics, energy and the environment, computer science, biomedical engineering, chemical engineering, electrical and computer engineering, mechanical engineering, or materials science. Students simultaneously take courses at the Simon School and the Hajim School.

The Master of Science degree will be conferred by the Hajim School and the Simon Business School.

For application information, contact:
Executive Director
University of Rochester
Center for Entrepreneurship
Website: www.rochester.edu/team

**Admissions and Financial Aid**
The Simon School encourages applications from men and women with diverse educational, professional, cultural, and geographic backgrounds. This rich mix of educational backgrounds and experiences greatly enhances classroom interaction and social life at the school.

MBA or MS applicants are expected to apply online through the website at simon.rochester.edu/applynow. Additional details on the admissions process and requirements are available by reviewing the application.

**Merit-Based Financial Aid**
The Simon School assists qualified full-time students in financing their management education and has been relatively generous in awarding merit-based scholarships to those who show promise of achieving excellence at the school and in their careers. In awarding merit-based aid, primary emphasis is given to academic excellence, professional development and demonstrated qualities of leadership.

These awards are renewed in the second year, provided first-year academic performance has been satisfactory. Consideration for the Simon School merit-based financial aid does not require a separate application.

Financial aid for international students is available, but competitive, and candidates must consider the costs of financing academic study in the United States. International students are also encouraged to investigate funding sources in their home countries as early as possible.

**Loan Programs**
The University of Rochester administers the full range of federal and private financial aid programs. International students may borrow, provided they have a cosigner who is a citizen or permanent resident of the United States.

Simon School also offers an International Student Loan Program to eligible full-time MBA students that does not require a U.S. cosigner. Contact the Simon MBA Admissions office for more details.

For further information on student loans, please contact:
University Financial Aid Office
Box 270261
University of Rochester
Rochester, NY 14627-0261
(585) 275-3226
(800) 881-8234 (toll free within the U.S.)
International Financial Aid
ACCOUNTING

401. Corporate Financial Accounting

Corporate financial accounting is concerned with the form and content of the information firms disclose to external parties (e.g., shareholders). In the United States, financial reporting is based on generally accepted accounting principles (GAAP) set by the Financial Accounting Standards Board (FASB). GAAP define the accounting methods and disclosure practices that firms select from when providing financial statements to external parties. This course covers these principles and other important financial reporting practices. The primary focus of the course is developing the skills required to interpret and analyze financial information; rather than the skills required to prepare financial statements. Upon completion of the course, students will appreciate how financial accounting information is used in contracts between parties (e.g., lenders and the firm) and to evaluate a firm’s past performance and potential future performance.

410. Strategic Cost Analysis

Prerequisites: ACC 401 and STR 401 or GBA 461; STR 403 (may be taken concurrently)

By examining the tension between decision-making and control in organizations, the course examines a variety of questions such as: Why do managers allocate fixed costs, transfer goods between sub-units at full cost, and use other accounting policies that deviate from marginal cost? What are activity-based costing, normal costing and economic value added (EVA), and why are managers adopting these techniques? Topics include: analyzing traditional costing systems, divisional performance measurement, transfer pricing, cost allocations, opportunity cost, budgeting and standard costing. The course provides students with a framework to understand and productively use accounting systems. Emphasis is placed on the problems of motivation and control in organizations and the role of accounting information in this context.

411. Financial Statement Analysis

Prerequisites: ACC 401 and FIN 402

An objective of this course is to develop students’ ability to use financial statement information (broadly defined) in various decision-making settings. The uses of financial statement information include: 1) evaluation of managerial performance; 2) analysts use financial statement information to perform prospective analysis, which serves as an input into the valuation of a firm’s equity. Analysts make buy, sell, and hold recommendations based on analysis of financial information; 3) creditors and lenders use financial statement information as input into lending decisions. Lenders use financial information to determine the type, amount, and terms of a loan, and also the nature of any covenants, and 4) corporations and investment bankers use financial statements to value companies that might be takeover targets. The primary objective is to develop and sharpen students’ analytical ability to analyze financial statements and draw inferences about a firm’s performance and future prospects. Cases and analysis of actual reporting practices are used to achieve the course objectives.

417. Auditing

Prerequisite: ACC 401

Auditing principles and procedures are examined. This course includes analysis of auditing and its relationship to financial reporting, with emphasis on the independent accountant’s attest function and consideration of ethical and legal responsibilities and regulatory influences. Statistical sampling, the role of the internal auditor, and compilation and review reports are discussed.

418. Taxes and Business Strategy

Prerequisites: ACC 401 and FIN 402

The objectives of this course are to help students develop the tools required to identify, understand, and evaluate tax-planning opportunities, and to develop a framework for understanding how taxes affect business decisions. Effective tax planning requires the planner to consider the tax implications of a proposed transaction for all of the parties to the transaction. Effective tax planning requires the planner, in making investment and financing decisions, to consider not only explicit taxes (tax dollars paid directly to taxing authorities), but also implicit taxes (taxes paid indirectly in the form of lower before-tax rates of return on tax-favored investments). Effective tax planning requires the planner to recognize that taxes represent only one among many business costs. In the planning process, all costs must be considered, including the costly restructuring of the business necessary to implement some tax plans. The framework is operationalized by applying it to a variety of settings such as investments, compensation policy, organizational form, regulated industries, financial instruments, tax-sheltered investments, multinational ventures, mergers and acquisitions and tax arbitrage.

419. Positive Accounting Research

This course is designed for MBA students concentrating in accounting, and students in the Master of Science in Accountancy program. The primary objective of the course is to introduce students to the role of financial accounting information in capital markets. This objective is accomplished by exposing students to academic accounting research on the relation between accounting numbers and stock prices, the debt contracting and executive compensation contracting roles of accounting numbers, incentives for managers to manage reported earnings, incentives for managers to voluntarily disclose financial information, properties of analysts’ forecasts of accounting numbers, and issues related to international financial reporting. Another objective of the course is to help students appreciate some of the current debates surrounding the accounting profession and the role of empirical research in addressing such problems.

423. Financial Reporting I

Prerequisites: ACC 401 and FIN 402

This course acquaints students with the conceptual and practical problems in measuring revenues and expenses, assets and liabilities. The principal objective is to make students proficient in assessing the financial position of a company, its cash flow, liquidity, capital structure, hidden liabilities, and reserves through
an understanding of generally accepted accounting principles (GAAP). The course provides a practical overview of the structure of accounting and its relation to finance and economics that should continue to be valuable as the accounting environment changes.

424. Financial Reporting II
Prerequisites: ACC 401 and FIN 402
This course addresses the accounting for mergers and acquisitions, foreign operations, and derivative financial instruments. Emphasis is placed on developing an appreciation of the forces shaping accounting, including the effects of organizational arrangements, information and taxes. The interdependency of the accounting methods, organizational structure, and tax decisions are investigated.

431. International Financial Statement Analysis
Prerequisites: ACC 401 and FIN 402
The objective of this course is to prepare students for the analysis of financial statements in an international context. Cross-border transacting is an increasingly important component of business. Consequently, corporate financial statements are used increasingly in international settings by shareholders, lenders, creditors, managers, employees, suppliers, customers and governments. Because the course aims to develop skills in international financial analysis, it adopts a case format. The course addresses the economic and political determinants of: 1) similarities in accounting practices among countries; 2) differences in accounting practices among countries; 3) similarities and differences in the properties of reported accounting numbers among countries; and 4) the strong trend toward reducing differences in accounting practices among countries.

433. Advanced Business Law and Ethics
(Same as BPP 433, a continuation of BPP 432)
Prerequisites: BPP 432
Topics include: bankruptcy, real property, personal property, sales, secured transactions, negotiable instruments, insurance, trusts and estates and consumer protection. This course also includes discussions of ethics and professional responsibilities.

436. Research Into Professional Accounting Standards
Prerequisites: ACC 401 and ACC 423
This course will cover the conceptual framework for standard-setting established by the Financial Accounting Standards Board (FASB). It will also review how to research financial accounting and reporting issues using the FASB Accounting Standards Codification. The research of financial accounting and reporting issues will be applied to professional accounting decisions in financial reporting, disclosure and other accounting decision making. In addition, a comparison of US Generally Accepted Accounting Principles (US GAAP) and International Financial Reporting Standards (IFRS) will be included. The course concludes with a review of the impact of governmental and not-for-profit accounting standards on financial reporting.

437. Basic Federal Income Tax Accounting
Prerequisite: ACC 401
This course introduces the federal tax system in the United States and will focus on specifics of federal tax code. It provides an overview of individual, partnership, corporate, gift and estate taxes. Detailed topics include, but are not limited to, gross income, deductions for adjusted gross income, deductions from adjusted gross income, taxable income, alternative minimum tax, certain tax credits, recognition of gains and losses, transactions between partners, Subchapter S Corporations, gift tax, and estate tax. Skills will be developed to research the tax code and I.R.S. rulings to solve tax issues.

438. Auditing II—Auditing and Information Systems
Prerequisites: ACC 401
This course will focus largely on Sarbanes-Oxley compliance and internal control systems. Internal control systems will be covered in depth, with focus on internal controls in an information technology (IT) environment. The IT environment will be discussed from the perspectives of designing effective internal controls and auditing in an IT environment. The function of the internal audit department will be covered, as well as how external auditors can work with internal auditors.

445. Managerial Accounting for Health Care Organizations
(Same as HSM 425)
Costs for health services continue to rise faster than overall economic growth drawing ever-greater attention from employers, governments, and consumers. The front line of the cost battle is within the health services entities where decision making depends on accurate reporting of internal costs. This course focuses on how costs are reported and how to use this information to make decisions within the health services entity. The following topics will be examined within a health services setting: cost allocation, cost-volume-profit analysis, budgeting and variance analysis, and transfer pricing.

501. Seminar in Accounting
(Offered each quarter, 1 credit. First-year PhD students are graded on a P/F basis. Second-year and later students receive a letter grade.)
A forum for the presentation, discussion, and critique of current accounting research papers where accounting faculty, PhD students, and outside speakers present working papers on current research topics. Students are expected to actively participate in the discussion and critique of the papers presented. In weeks when accounting workshops/seminars are scheduled, accounting PhD students will meet as a group with a member of the accounting faculty before the seminar to discuss the paper. Since such meetings are designed to facilitate students’ active participation in the seminars, students are required to circulate a brief set of comments to the other class participants in advance of the meeting. Grading will be based on the quality of students’ contributions to the pre-seminar meetings as well as their contributions and participation in the actual workshops.
510. Accounting Research I
(Offered Fall Quarter, 3 credits.)
The natural starting point for the study of capital markets research in accounting begins with the relationship between accounting earnings and security returns. This course covers the evolution of research on the earnings/return relation from the seminal papers up through current research. Topics covered include the fundamental features of the contemporaneous earnings/return relation, the nature of association-type and event study-type investigations of the contemporaneous earnings/return relation, theoretical and empirical evidence on the lead/lag relation between security returns and accounting earnings, the asymmetric timeliness of accounting earnings, theoretical and empirical research on the role of conservatism in accounting earnings, pro-forma earnings, and international research on the characteristics and properties of the earnings/return relation. The course also covers capital market research on analysts' earnings forecasts including the properties of such forecasts (e.g., optimism, pessimism, rationality) and the relation between analyst earnings forecasts and stock prices.

511. Accounting Research II
(Offered Winter Quarter, 3 credits.)
Prerequisite: ACC 510
This course turns the focus from aggregate accounting earnings (which is studied in ACC 510), to the components of earnings: accruals and cash flow. Given the central role of accruals in the measurement of accounting earnings, the initial focus of the course is on the fundamental properties of accruals and the importance of accruals to accounting earnings central role as a summary measure of firm performance. The course also covers the relation between cash flow and accruals and the market pricing of accruals and the components of accruals. The study of accruals naturally leads to research on earnings management that focuses on how and why earnings are managed. Research on how earnings are managed focuses on managers’ opportunistic manipulation of accounting accruals and/or via altering real activities while research on the managerial incentives to manage reported earnings focuses on (among other topics) the literature on meeting or beating earnings expectations and earnings thresholds. The course also covers the topic of voluntary disclosure. In particular, the incentives managers have to voluntarily disclose earnings and/or cash flow forecasts and the properties and stock price effects of such forecasts. Other voluntary disclosure literature studied includes the effect of voluntary disclosure on the cost of capital and the effect of the legal environment on firms’ voluntary disclosure practices.

512. Advanced Topics in Accounting Research
(Offered Spring Quarter and alternates with ACC 513, 3 credits.)
Prerequisites: ACC 510 and ACC 511
This course covers advanced topics in accounting research including the role of accounting numbers in debt contracts and lending agreements, the role of accounting numbers in executive compensation contracts and corporate governance, the economic consequences of accounting regulation, the use of accounting-based measures of the cost of capital, and empirical tax research in accounting.

513. Contemporary Topics in Accounting Research
(Offered Spring Quarter and alternates with ACC 512, 3 credits.)
Prerequisites: ACC 510 and ACC 511
This course covers topics including value relevance, accounting-based valuation models, earnings quality, the impact of earnings and accrual quality on firm valuation, the impact of real activity management on firm performance, market efficiency with respect to accounting numbers, the economic consequences of fraudulent financial reporting, and the effects of accounting restatements.

APPLIED ECONOMICS

504. Fundamentals of Economics
This is a course meant for entering doctoral students with insufficient background in economics. Topics covered include markets and prices, consumer behavior, individual and market demand, choice under uncertainty, production, competitive markets, monopoly and monopsony, competitive strategy, markets with asymmetric information, externalities, and public goods. Offered in the summer, primarily for entering doctoral students.

505. Real Analysis
The course introduces mathematical tools especially useful in economics, econometrics, and finance. Topics include a basic topology of the real line, sequences and series, limits, continuity, differential and integral calculus. Offered in the summer, primarily for entering doctoral students.

506. Probability Theory
This course teaches Random Variable, Distribution, Independence; Transformations and Expectations; Common Families of Distributions; Multiple Random Variables, and Markov Chains. Offered in the summer, primarily for entering doctoral students.

510. PhD Workshop in Applied Economics
Prerequisite: permission of the instructor
The workshop provides a forum for the presentation of ongoing and completed research projects by PhD students in the economics core. Third- and fourth-year PhD students are expected to participate actively.

511. Advanced Price Theory I
Provides a survey of the substance and methods of contemporary price theory for students preparing to do research. Generally, the course covers the economic behavior of individuals and firms in a competitive market setting. Individual behaviors examined include responses to price and income changes, intertemporal planning (e.g., saving), household production, labor supply, investment in human capital, search, and reactions to uncertainty about future assets and goods prices. For firms, the implications of value-maximization for input demands and output supplies
are explored thoroughly. Managerial choices related to multiple products, intertemporal production planning and uncertainty are explicitly modeled. Some extensions to monopoly behavior are considered. Finally, some implications of consumer and competitive firm behavior for industry (single market) and general equilibrium are examined. These include (for industry equilibrium) the technological determinants of industry responses (entry-exit, quantity changes, price changes) to economic shocks such as shifts in demand for the industry's product. For general equilibrium, the first and second welfare theorems will be covered. This course follows the semester schedule.

513. Industrial Organization Theory
This course provides an introduction to the theory and practice of industrial organization. Broad areas of application include static oligopoly models, two-stage games and games with infinite horizons. Concepts from game theory such as Nash equilibria, subgame perfect equilibria, and perfect Bayesian equilibria will be used as needed. Special topics may include: contracts, patents, licensing, bundling, tying, buyer-seller networks, switching costs, price discrimination, mergers and entry barriers.

514. Game Theory
This course teaches the tools of game theory and contract theory, and applies them to topics in industrial organization, organizational economics and other areas. Game theory is the study of strategic interaction among a small number of decision-makers. Nowadays, it is applied in almost any area of economics, as well as in related disciplines such as finance, accounting, marketing, and operations research. Contract theory is concerned with the optimal design of contracts (and at a larger scale, organizations) that define the “rules of the game” under which agents (such as a firm’s employees) interact. In this sense, it can be thought of as an extension of game theory. Contract theory is the methodological basis of much of modern organizational economics, but its methods are applied in many other contexts, too notably, finance. The course is organized by concepts and methods, but most time will be spent on applying them to a large variety of topics.

520. Causal Inference
This course teaches the tools of game theory and contract theory, and applies them to topics in industrial organization, organizational economics and other areas. Game theory is the study of strategic interaction among a small number of decision-makers. Nowadays, it is applied in almost any area of economics, as well as in related disciplines such as finance, accounting, marketing, and operations research. Contract theory is concerned with the optimal design of contracts (and at a larger scale, organizations) that define the “rules of the game” under which agents (such as a firm’s employees) interact. In this sense, it can be thought of as an extension of game theory. Contract theory is the methodological basis of much of modern organizational economics, but its methods are applied in many other contexts, too notably, finance. The course is organized by concepts and methods, but most time will be spent on applying them to a large variety of topics.

521. Advanced Topics in the Organization of Industry
The course concentrates on unsettled areas in industrial organization, exposing students to potential thesis and research projects. Specific topics vary from year to year. Typical current topics are theory of conglomerate mergers, analysis of advertising and scale as barriers to entry, quality competition and market responses to costly information.

523. Micro-Econometric Modeling: Static Approaches
This course introduces students to canonical modeling approaches for analyzing decision making by both firms and consumers, focusing on static environments. Central topics include demand estimation, models of strategic interaction, networks and platforms and auctions. Applications include firm pricing decisions, new product introductions, strategic entry and vertical relationships. The course generally includes coding assignments and student presentations, in addition to the weekly lectures on methods and applications.

524. Micro-Econometric Modeling: Dynamic Approaches
This course examines consumer and firm behaviors that involve inter-temporal trade-offs and as a result involve dynamic optimization on the part of both consumers and firms. It begins with an overview of dynamic programming methods, in both single and multi-agent settings, emphasizing methods that link estimation with computation. Single agent topics include models of capital replacement, dynamic demand, inventory models and salesforce management. Multi-agent topics include strategic innovation, learning by doing, demand smoothing, and product repositioning. A strong emphasis is placed on recent methods and frontier topics. The course generally includes coding assignments and several student presentations, in addition to weekly lectures.

525. Mathematical Economics I
(Same as ECO 481)
(Offered at the discretion of the instructor)
Credit—four hours
Prerequisite: AEC 505

This course covers the use of optimization theory in economic analysis. The topics covered include finite-dimensional optimization (unconstrained optimization, Lagrange’s Theorem, the Kuhn-Tucker Theorem), the role of convexity in optimization, parametric continuity of solutions to optimization problems, and finite- and infinite-horizon dynamic programming.

525. Mathematical Economics I
(Same as ECO 481)
(Offered at the discretion of the instructor)
Credit—four hours
Prerequisite: AEC 505

This course covers the use of optimization theory in economic analysis. The topics covered include finite-dimensional optimization (unconstrained optimization, Lagrange’s Theorem, the Kuhn-Tucker Theorem), the role of convexity in optimization, parametric continuity of solutions to optimization problems, and finite- and infinite-horizon dynamic programming.
APPLIED STATISTICS

425. Advanced Managerial Data Analysis
Prerequisites: GBA 412 or GBA 462
The objective of this course is to provide a systematic way to organize and make use of quantitative information in business decision-making. The course builds on what students have learned in introductory statistics, extending that knowledge to include the situations frequently encountered in decision-making.

511. Introduction to Mathematical Statistics
A more theoretical treatment of the subject matter of APS 411, offered in the summer, primarily for entering doctoral students.

514. Introduction to Econometrics
(Same as College course ECO 484)
Credit—two hours
Prerequisites: AEC 505 or equivalent and APS 511 or equivalent
The course is for students intending to do research in quantitative areas. Topics include: estimation and hypothesis testing in the standard linear model, weighted least squares, transformations, constraints, analysis of variance and covariance and problems of model specification.

515. Elements of Econometrics
(Same as College course ECO 485)
Credit—four hours
Prerequisite: APS 514
The course starts with the single-equation linear model, focusing on OLS estimation and instrumental variables estimation. Then it moves to a linear system of equations model and covers system OLS estimation, generalized least squares estimation, and generalized method of moments. It ends topics of the linear model with linear unobserved effects panel data models. Then the course moves to nonlinear estimation, covering the M-Estimators and discrete response models. If time permits, a few more advanced topics will also be covered. The course assumes familiarity with matrix algebra, probability theory, basic statistics, and econometrics at the level of ECO 483 and ECO 484. The course requires programming in Matlab for some problem sets.

519. Topics in Microeconometrics
Prerequisite: ECO 517 or permission of the instructor
The course content varies from year to year. Panel data, cross-section time series, qualitative dependent variables and duration analysis are possible topics discussed.

523. Advanced Econometrics
(Same as College course ECO 517)
Credit—five hours
Prerequisite: APS 515
The course covers advanced topics in econometrics, including maximum likelihood methods and methods of moment estimation. Also discussed are asymptotic theory, and semiparametric and nonparametric estimation.

524. Topics in Macroeconometrics
(Same as College course ECO 518)
Credit—five hours
Prerequisite: APS 523 or permission of the instructor
The course focuses on the econometric techniques and problems associated with particular fields in economics, such as the econometrics of labor economics and the econometric issues in macroeconomics or finance.

528. Sampling Techniques
(Same as Medical School course BST 421; APS 528 is offered in alternate years)
Credit—four hours
Prerequisites: GBA 411, GBA 412 and differential calculus
The course is for students with a primary interest in applied statistics or research in quantitative areas. Topics include: design and analysis of simple random, stratified, cluster and systematic sampling; multistage and multiphase sampling; and nonresponse and measurement errors.

529. Applied Multivariate Analysis
(Same as Medical School course BST 441; APS 529 is offered in alternate years)
Credit—two hours
Prerequisite: APS 514
This course examines the theory and applications of multivariate methods often used in economics, marketing and finance. Topics include: multivariate normal distributions, sampling distributions, tests of hypotheses, multivariate analysis of variance, canonical correlation, principal components and factor analysis.

531. Applied Econometrics
The course aims to provide PhD students with a broad set of applied econometric skills. The contents of the course have been designed as to provide the broadest group of students fairly in-depth exposure to key topics in Panel Data methods that would be useful in their research endeavor. These methods have applications in accounting, corporate finance, marketing, and more recently in operations management and information systems. The course will be broken up into four modules. The first module is a refresher to topics already covered in the introductory sequence of econometrics courses. The focus, however, would be for students to grasp the idea behind the methods in a more applied setting. The second module introduces students to Panel Data and the issues involved with the estimation of models based on such data. The third module forms the core of the course and focuses on simulation-based econometric methods. In this module, the models discuss both reduced form and structural models applied to cross sectional as well as Panel Data. The course concludes with a quick introduction to Bayesian ideas and methods.
BUSINESS COMMUNICATIONS

401/461. Professional Communication
This course establishes the conceptual foundation and the learning method for the MGC sequence. It anchors the course in two conceptual frameworks: the rhetorical principles of logic and persuasion, and the interactional approach to communication in groups and professional relationships. It introduces the teaching model for the course: speaking and writing assessments, case analyses and discussion, successive rounds of business presentations and writing assignments, and repeated practice in active listening, and giving and receiving performance feedback.

402/462. Communicating Analytics
This course applies the principles of persuasion and logic of argument established in MGC 401/461 in successive rounds of presentation practice, coupled with peer and self-review. Presentations stem from analyses of business problems using the Simon problem-solving framework and make recommendations aimed at influencing decision makers in varying functions and at different levels. Students facilitate discussions of readings, give one team presentation, develop behavioral interview skills, and, as in all quarters of MGC, give and receive feedback in both informal and formal ways.

403/463. Teamwork
This course applies the interactional concepts of group dynamics introduced in MGC 401/461 to team formation and performance, through focus on business cases and field projects. Foundational concepts in group dynamics, meeting management, intercultural communication, and conflict resolution are examined through the lens of team activity. Team projects culminate in presentations and written reports, with integrated processes for self and team evaluation.

411. Interpersonal Persuasion and Influence
This course applies the concepts of persuasive communication to a widened range of workplace settings, including team projects in business case analysis and persuasion for decision makers; one-to-one and multi-party negotiations; and managerial interactions employing feedback for skill development and improved performance. The course culminates with identification of goals for improving individual communication competency as related to career progress.

BUSINESS ENVIRONMENT AND PUBLIC POLICY

426. Macroeconomics
Macroeconomics is the study of how economies grow and fluctuate over time, and how they interact with one another. In this course, we discuss economic measurement, economic growth, and the business cycle. We also discuss the implication of modern theories of growth and fluctuation for the conduct of monetary policy and fiscal policy. There is a strong emphasis on the international linkage among economies and the implications of macroeconomics for the business environment.

431. Legal and Tax Considerations of New Ventures (Same as ENT 431)
(Offered at the discretion of the instructor)
This course surveys, from the entrepreneur's perspective, legal and tax considerations that impact strategic choices in organizing, funding, staffing, governing, and operating new ventures. The course's principal focus is on how to create and retain competitive advantage through the skillful ordering of legal affairs. Emphasis will be transactional and include analysis of such issues as the creation and protection of intellectual property, technology licensing, global expansion, and internet commerce. The course will include, as a context for applied learning, a term project involving the creation and evolution of a selected new venture opportunity.

432. Basic Business Law (Same as ENT 432)
This course surveys the law of contracts, agency, and business associations – with the objective of developing familiarity with selected laws, regulations, legal principles, and legal processes that govern (a) efficient exchange, generally; and (b) how and in what ways managers and entrepreneurs organize and interact to facilitate exchange. Although emphasis will be on United States law, there will be selected reference throughout the course to issues related to international transactions and to pertinent differences in legal systems of countries outside the United States. The course has a distinct transactional focus, with heavy reliance upon contemporary cases, commercial practices, and issues. Particular attention will be given to the impact of the legal framework upon sound managerial decision-making, business risk management, commercial rights and responsibilities, and ultimately business valuation.

433. Advanced Business Law and Ethics
Topics include: bankruptcy, real property, personal property, sales, secured transactions, negotiable instruments, insurance, trusts and estates and consumer protection. This course also includes discussions of ethics and professional responsibilities. Prerequisite: BPP 432
COMPETITIVE AND ORGANIZATIONAL STRATEGY

401. Managerial Economics
The primary objective of the course is to train students to think in economic terms, to identify the relevant economic issues in a given situation, to separate the relevant from the irrelevant, and to analyze the implications of alternative actions. Another objective is to provide an increased understanding of markets. The course presents the basic analytical tools of microeconomics, particularly as those skills are relevant to managers. Important economic concepts used in subsequent courses, such as opportunity costs and a Nash Equilibrium, are covered. Applications of marginal analysis are stressed.

403. Organization and Strategy
Prerequisite: STR 401 or GBA 461
The course teaches how to approach and solve a large range of organizational problems from an analytical-economic perspective that is grounded in agency theory. It discusses in detail the assignment of decision rights (including centralization vs. decentralization of decisions), performance measurement, and incentives and rewards. These are the three elements of “organizational architecture,” the central framework of the course. Applications range from job-level incentive problems to broader questions about organizational structure and the boundaries of the firm (e.g., vertical integration). Throughout, the course emphasizes the complementarity of organizational policies and the importance of alignment between a firm’s internal organization and its strategy.

421. Economics of Competitive Strategy
Prerequisite: STR 401
Competitive strategy deals with the most significant decisions that companies make in the marketplace, including entry into a market, product positioning, pricing, investments, technology choice and acquisitions. This course provides tools and concepts for analyzing these decisions and for designing business strategies that help firms make above-normal profits in the long run. Throughout the course, there is an emphasis on how firms interact with existing or potential competitors and other parties in the market. The tools and concepts used to understand this interaction are partly those of the traditional field of Strategic Management, but more importantly those of modern microeconomics, especially the field of Industrial Organization. The first half of the course looks at the “big picture” and covers industry analysis, value creation and competitive advantage, and integration and diversification decisions. The second half of the course focuses on strategic interaction among firms, and covers specific topics such as the dynamics of price competition in oligopolies, commitment strategies of firms, entry and exit, networks and standards, and technological competition. The course is largely case-based. About one third of all classes are lectures; the other two thirds are case discussions.

422. Game Theory for Managers
Prerequisite: STR 401 or GBA 461
This course develops game-theoretic tools that can be used to provide both quantitative and qualitative prescriptions for profit-maximizing behavior in a variety of strategic settings. The basic concepts are introduced through applications to strategic settings that one encounters in typical business situations. However, the game-theoretic concepts themselves are quite general, as the goal of the course is provide students with both an understanding of these concepts, and a tool kit with which to evaluate a broad range of strategic problems. The set of strategic problems specifically discussed includes the pricing of new and existing goods in the presence of substitutes and complements, determining advertising and R&D expenditures, analyzing market entry, exit, and entry deterrence opportunities, and evaluating bargaining and auction environments. Extensive use is made of examples from both private- and public sector analyses of strategic interactions among firms.

423. Pricing Policies
(Same as MKT 414)
Prerequisites: STR 401 or GBA 461 and MKT 402
This course prepares future managers to analyze the environment in which their firm operates in order to arrive at an appropriate pricing policy for their products or services. Topics include (i) relevant costs (i.e., which costs are relevant for pricing decisions), (ii) elasticity of demand, and (iii) market segmentation (e.g., through the offering of a product line, or by means of bundling, tying, menus of two-part tariffs, quantity discounts, and other direct and indirect means of price discrimination). The course will also cover essential pricing analytic tools such as break-even analysis and economic value analysis, and it will provide a solid introduction into the pitfalls of pricing in a competitive environment and how to anticipate competitor responses. Lastly, the course will cover the legal aspects of pricing as appropriate.

424. Human Resource Strategy
Prerequisite: STR 401 or GBA 461
Recommended: STR 403
This course analyzes human resource management from an economics perspective. It focuses primarily on the implementation of compensation and incentive structures in organizations. Topics include: selection and hiring of employees, measurement and appraisal of employee performance, promotion-based incentive
427. Organizational Behavior
This course presents behavioral concepts that influence individual, group, and organizational effectiveness. Particular emphasis is given to motivation, culture, globalization, leadership, group dynamics, communication, organizational structure and change. Students develop ways of thinking about organizational problems to increase individual and organizational effectiveness. Multiple stakeholder perspectives and systemic approach to organizational problems are emphasized.

429. Advanced Competitive Strategy
Prerequisite: STR 421
This course builds on STR 421 to train students in conducting and communicating strategic analysis. The course provides an end-to-end methodology for evaluating and developing business strategy. Students learn and practice framing an unstructured strategic challenge, constructing workable questions, collecting and evaluating the required evidence and formulating strategic recommendations. The course is split between work on a quarter-long project, lectures, and case studies.

430. Health Sciences Management and Strategy
(Same as HSM 430)
Prerequisite: STR 401 or GBA 461
Recommended: STR 403, STR 421
This course applies the principles of organizational economics and strategy to the institutional setting of health sciences. The course focuses on the interdependence between the delivery, financing, and technology sectors of the health care marketplace. It discusses how management and strategy choices within each sector are responses to the unique institutional factors in the health care marketplace and how the strategies of each sector affect the behavior of the others. Students will leave the course with an ability to think productively about management and strategy challenges within each of the three health science sectors.

438. B2B Pricing
(Same as MKT 438)
Prerequisite: STR 423
Students will learn the major differences in pricing strategies between selling to consumers (STR 423) and to other firms, which then deal with consumers. The course starts by analyzing the pricing problem of a manufacturer selling to a retailer. We examine the issue of double marginalization, and learn how two-part tariffs get us out of this problem. We also examine different forms of contractual relations—from vertical acquisitions to regular short-term contracts—and potential issues with every form, touching on transfer pricing and outsourcing. In the second part of the course, we analyze a crucial concept of cost pass-through (how much a retailer should decrease the retail price in response to a decrease in the wholesale price) and the effect of manufacturer’s advertising on the retailer and on the channel overall. This course is a natural continuation of STR 423 Pricing Policies for those who are interested in working in an industry where a significant portion of sales is done through independently-owned retailers, whether students are planning on working on the retailer side or on the manufacturer side of this industry.

439. Advanced Pricing
(Same as MKT 439)
Prerequisite: MKT 414 or STR 423
This course builds on MKT 414/STR 423 to equip students with the skills to make profitable pricing decisions in complex business environments. Topics include: pricing with constrained supply and uncertain demand; markdown management; advance selling; pricing on the internet; selling through auctions; pricing in markets with (direct and indirect) network effects; and psychological aspects of pricing.

440. Corporate Governance
Prerequisites: STR 401 or GBA 461 and STR 403
This course builds on STR 403 Organization and Strategy to provide a more in-depth analysis of organizational choice and governance mechanisms. Topics include: the choice of organizational form; corporate charter (voting rules, anti-takeover provisions, and so on); proxy process; board of directors; ownership structure; banks and other financial institutions as organizational monitors; CEO selection, retention and succession; and governance in entrepreneurial firms. The class presents the important issues relating to these topics and examines the relevant empirical research. Emphasis is placed on how optimal practices can vary across industry, strategy, and country and on how they might evolve through time. The course complements FIN 411 (Investments) and FIN 423 (Corporate Financial Policy and Control) in helping students understand how corporate policies affect security prices and value.

442. Special Topics in Strategy
Prerequisite: permission of the instructor
Special topics are generally those which are not well covered in the other courses, such as advanced pricing techniques, or they may deal with strategy in selected industries (e.g., financial services, high-tech marketing, etc.). The specific content of the course varies, depending on faculty interests.

461. Strategy and Business Systems Consulting Practicum
(Same as CIS 461 and OMG 461)
This course provides students with an introduction to strategy and business systems consulting. It is aimed at students who wish to explore career opportunities within the major consulting firms, but is also relevant for students considering a career as an independent consultant, or within a corporation’s internal consulting group. The course focuses on three areas:
1. The Consulting Industry: Students will examine several types of consulting (e.g., strategic, operations, systems,
human resource and marketing) and understand where the major consulting firms position themselves. The career paths for students entering the industry, and the skills and values necessary for success as a consultant will be scrutinized.

2. The Business Systems Consulting Process: The creation of proposals, the winning of consulting engagements, and the preparation of contracts will be discussed. The typical stages of a business systems consulting engagement (e.g., problem framing, analysis design, gathering data, interpreting results, architectural solution, and presentation of recommendations) and managing different sorts of consulting projects (e.g., operational improvement, supply-chain optimization, quality improvement, strategy formulation, and organization design) will be examined.

The course examines a wide range of modern global business challenges and opportunities from both the consultant’s and the manager’s perspectives and provides a learning platform to integrate and practice the skills and knowledge learned.

501. Organizational and Competitive Strategy Seminar
(Same as AEC 503)

A continuation of AEC 501 and AEC 502

510. Research in Organizational and Competitive Strategy
Prerequisite: STR 403 or permission of the instructor

This course provides a forum for discussing theoretical and empirical research on organizational and competitive strategy, and it contains the core material for preparing for a minor exam in STR. The course covers topics similar to those in STR 403. However, students study more advanced papers and analyze the material with more depth and rigor. Depending on the backgrounds and interests of the students, likely topics include: why firms exist; why organizations take the form that they do; the motivations for change within organizations; incentive problems and contracting; the factors that determine the allocation of decision rights within an organization; how agency problems are mitigated by the market for corporate control; the managerial labor market; compensation plans; the ownership structure of residual claims and the court system; and why “hybrid” organizations such as franchises and joint ventures exist.

### COMPUTERS AND INFORMATION SYSTEMS

#### 401. Information Systems for Management

This course focuses on the theoretical foundations underlying management information systems and their vital role in the modern business environment. Topics include: information economics; innovative models of e-business and the impact of the Web on organizational transformation; the nature and operation of large-scale-enterprise in-formation systems; database and knowledge management systems; data communications; electronic commerce; business process re-engineering; and information-systems analysis, design and control. The strategic and economic impacts of competitive information systems are emphasized. Assignments and cases introduce students to modern quantitative business modeling concepts and analysis, and to sophisticated business applications of the Web and databases.

#### 413. The Economics of Information Management

Prerequisites: CIS 401 and STR 401 or GBA 461

This course covers economic approaches to the management of information systems (IS). Topics include: the value of information in an organizational setting; cost trends in hardware and software; the nature and implications of information asymmetries and objective conflicts in the IS setting, such as introducing new technology in an organization, the use of pricing and other control mechanisms such as budgets and corporate standards to manage IS re-sources; analysis of peak-load problems; outsourcing and EDI issues; and the effects of queuing and its associated externality. Several business cases are used to illustrate the issues.

#### 415. Business Process Analysis and Design

Prerequisite: CIS 401

This course studies the analysis, design, and automation of business processes. The course teaches system-modeling tools appropriate for the analysis and design of business processes and information systems. These tools are applied to electronic commerce ventures, the design of various service processes, logistics, and R&D activities. Key features of the course are: modern process analysis techniques, the study of cutting edge research results on work organization and design, and an introduction to rapid prototyping of new information systems. The course includes a comprehensive team-based field project involving a real business process. This project requires the application of the concepts and techniques taught in the course.

#### 416. Advanced Information Technology

Prerequisite: CIS 401

Information has become increasingly important to the modern corporation for conducting operations, improving efficiency, and maintaining competitiveness in rapidly changing markets. Effective use of information technology (IT) involves knowledge of the existing capacities, awareness of how information technology is changing, and imaginative use of the technology to enhance business performance. The course contains a broad coverage of trends in IT development (e.g., hardware, software, systems architecture, networks, security, etc.), and how these components
can be used for new business applications. The emphasis is not
on the technology, but rather on managerially evaluating its
usefulness for solving business problems. Topics to be covered in-
clude: client-server architecture, data warehousing, data mining,
decision support, enterprise resource planning, knowledge-based
systems / artificial intelligence, networks and security, object-
oriented and Web-based programming languages, and technol-
gy for project managers. All students are required to complete a
group project on the business implications of these technologies.
They have to look at these technologies from the perspective of a
business consultant who needs to understand how to match the
right technology with his or her customers’ business problems.

417. Introduction to Business Analytics
Prerequisite: GBA 412 or GBA 462

This course covers the emerging field of business analytics (BA)
or ‘data mining’ and expands and develops the students’ analyti-
cal tool kit in analyzing massive data sets. Using case studies and
hands-on data sets, students will learn advanced data query tech-
niques, data cleaning and organization, explore various machine
learning techniques including supervised and unsupervised
classification schemes, text classification, clustering techniques as
well as predictive analytics. Students will gain hands-on experi-
ence with a variety of software tools, including SQL, SAS, R,
Tableau, and Weka – an open source platform for data mining.

418. Advanced Business Modeling and Analysis Using
Spreadsheets

The course expands and develops students’ analytical tool kit
through “hands on” training in the effective use of spreadsheet-
based tools for advanced managerial analysis. Students perform
quantitative analysis of advanced problems in options pricing,
investments, corporate finance, marketing, and operations. The
course enhances and reinforces the analytical skills developed in
earlier MBA classes such as formulating and solving large-scale
business problems using quantitative models, risk simulation and
sensitivity analysis. Spreadsheet tools introduced in this class
include Visual Basic for Applications (V.B.A.) and stochastic
optimization using Optquest. Students who successfully com-
plete the course should possess cutting-edge skills in spreadsheet
business modeling and analysis.

434. Social Media Analytics

The rise of social media has empowered customers in an
unprecedented way. They are well connected with each other
through platforms like Facebook and Twitter, and they can easily
express and distribute their criticisms or endorsements publicly
to large audiences in real time. This fundamental shift in power
is forcing companies to actively manage their presence on social
media platforms. Technology and strategies are increasingly
intertwined in this new frontier of innovation and competition.
This course draws on a unique blend of social media strategies and
the rapidly evolving information technologies supporting these strategies. We will discuss issues related to the monitoring,
analyzing, and designing of social media for companies in different
industries.

437. Digital Marketing Strategy
(Same as MKT 437)
Prerequisite: MKT 402

This course examines the major issues involved in marketing on
the Internet. Among the topics studied are: new product op-
portunities on the Internet; the changed role of advertising; the
Internet as a two-way communication medium with consumers;
targeting individual consumers; word-of-mouth among consum-
ers on the Internet; the Internet as a distribution channel; and
marketing research on the Internet.

440. Electronic Commerce Strategy
Prerequisite: CIS 401

This course covers electronic strategies for business-to-business
and consumer e-commerce. This includes strategies for protect-
ing market share by going online, ameliorating online competi-
tion using network effects and customer lock-in, positioning
against other online presences, dealing disintermediation and
re-intermediation, developing online communities for busi-
ness or consumer e-commerce, and managing supply chain and
customer relationships.

442. Special Topics in Computer and Information Systems
Prerequisite: Established by the instructor

Special topics are generally those which are not well covered in
other courses. The specific content varies, depending on faculty
interest.

446. Financial Information Systems
(Same as FIN 446)
Prerequisites: CIS 401 and FIN 402

This course examines the role that advances in telecommunications,
the Internet, and information systems play in the financial
markets and the financial services industry. An in-depth under-
standing of operations of industry is developed while studying
technology’s transformative role. The class explores subjects
such as electronic trading systems competing with traditional
exchanges and Internet brokerage firms challenging full-service
brokerage firms and banks for customers. How trends in these
areas will appear in other kinds of electronic commerce are
discussed, the latest developments in financial markets and the financial services are examined, and case studies are used in many classes.

461. Strategy and Business Systems Consulting Practicum (Same as OMG 461 and STR 461)

This course provides students with an introduction to strategy and business systems consulting. It is aimed at students who wish to explore career opportunities within the major consulting firms, but is also relevant for students considering a career as an independent consultant, or within a corporation’s internal consulting group. The course focuses on three areas:

1. The Consulting Industry: Students will examine several types of consulting (e.g., strategic, operations, systems, human resource, and marketing) and understand where the major consulting firms position themselves. The career paths for graduates entering the industry, and the skills and values necessary for success as a consultant will be scrutinized.

2. The Business Systems Consulting Process: The creation of proposals, the winning of consulting engagements, and the preparation of contracts will be discussed. The typical stages of a business systems consulting engagement (e.g., problem framing, analysis design, gathering data, interpreting results, architectural solution, and presentation of recommendations) and managing different sorts of consulting projects (e.g., operational improvement, supply-chain optimization, quality improvement, strategy formulation, and organization design) will be examined.

3. Consulting Skills: The role of the consultant and the human dimension will be discussed (e.g., personal attributes of consultants, relationship building, and team building). Diagnostic tools and data gathering techniques (e.g., questionnaires and interviews) will be presented. Frameworks for problem solving, and communicating recommendations will also be introduced. The course examines a wide range of modern global business challenges and opportunities from both the consultant’s and the manager’s perspectives and provides a learning platform to integrate and practice the skills and knowledge learned.

465A/B. Practicum in Business Analytics I & II

This course provides MS and MBA students with the opportunity to use the skills they have developed through other coursework in statistics and analytics to the development and execution of a capstone project. The projects, using real-world situations and data, will serve as preparation for careers in industries such as marketing, consulting, and finance that require extensive knowledge and application of data science.

501, 502, 503, 521, 522, 523. PhD Seminars in Computers and Information Systems

Prerequisite: permission of the instructor

These six PhD seminars are offered in the fall, winter, and spring quarters, with topics selected from the following: decision-support systems, economics of information and the valuation of information systems, issues in the management of information systems and the economics of computing, advanced topics in systems analysis and design, organizational aspects of information systems, logical and physical database design, and topics discussed in the joint CIS/OMG PhD seminars.

512. Advanced Topics in Database Design

Prerequisite: CIS 415 or permission of the instructor

This course examines current research issues in database management systems. Topics include: database-design methodologies, semantic models, semantic integrity constraints, object-oriented approaches and applications of artificial intelligence to database management systems.

ENTREPRENEURSHIP

422. Generating and Screening Entrepreneurial Ideas

As the foundation course in Entrepreneurship, this course covers: idea generation, opportunities screening, entrepreneurial characteristics. This course outlines a critical evaluation process used by successful entrepreneurs to prioritize new venture ideas. The focus of this course is on the technical and market evaluation of very early-stage ideas when information is greatly lacking, and the time and money to research such answers is also limited. Students, in group format, generate and filter their own ideas and evaluate them based upon technical merit, business challenges, and early market indicators. Teams present their idea-filtering rationale to a panel for review and feedback. Behind this evaluation process, the class review reference material on the subject and several accomplished entrepreneurs will share their personal experiences. While the nomenclature align most directly to high-technology for-profit start-up companies, parallels to low-tech-no-tech, intra-preneurship, non-profits, and social entrepreneurship will be discussed.

423. New Venture Development and Managing for Long Term Success

The focus of ENT 423 is learning how to prepare an effective business plan that will communicate the inherent value of the concept. Among the critical issues that will be addressed are: competitive conditions and industry trends, sustainable competitive advantages, management team, marketing plan, financial plan, exit possibilities, franchising, legal entities. The approach used is appropriate for start-ups and for corporate venturing. It is also suitable for both profit and for not-for-profit organizations. Also included is a social entrepreneurship module. At the same time plans are prepared, other entrepreneurial issues are studied, such as assembly resources, launching and building new ventures and harvesting results. Lectures, cases and guest speakers are utilized. The speakers will address a range of new venture topics from the development of management teams, marketing, finance, venture capitalists and legal issues. The completion of a business plan for a proposed new venture is required.
424. Projects in Entrepreneurship  
Prerequisites: Completion of core courses, and either ENT 422, 423 or 425. Permission of the instructor must be secured prior to registration.

This course combines a supervised internship with a start-up firm with lectures and in-class discussion on the management of new ventures. The internship places students with Rochester-area firms where they work closely with senior managers for approximately 120 hours over an academic term. In their internship, students will focus on the commercial viability of the firm’s offerings. This will be accomplished through shadowing management, reviewing reports, participation in meetings and work assignments. Complementing this hands-on entrepreneurial experience are weekly classes held to discuss student experiences. In addition, there will be lectures on pertinent entrepreneurial subjects as well as guest speakers.

425. Technical Entrepreneurship

This course provides an opportunity to examine the management practices associated with technical innovation and new business development. The analysis of entrepreneurship is evaluated primarily from the perspective of a start-up venture that requires equity capital investment. Management issues discussed include organizational development, analysis of market opportunities, market engagement, financial planning and control, capitalization, sources of funds, the due-diligence process, and valuing the venture. An important reason for taking this course is to learn how to develop a business plan. Therefore, a significant component of a student’s final grade will be based on this. In too many instances, a new venture does not become a viable entity because either there is no plan, or if there is, it is poorly conceived. Furthermore, a good plan is an effective communications tool for the investment community. An additional benefit is learning to work in multidisciplinary teams. Teams of three to four students collaborate in the preparation of a business plan. The course includes time for students to share business ideas and identify possible team members. In general, each team includes two students and two science/technology graduate students. Other team configurations are possible with instructor approval. Each team’s business plan will receive a grade and that grade will apply to each individual on the team. Each team has a coach who is an experienced businessperson. The coach is available to provide feedback to the team. This course is cross listed at OPT 481 and is taught by a faculty member at Simon and is from Engineering.

426. Technology Transfer and Commercialization

The creation of value in today’s globally competitive environment is increasingly driven by technology. Corporations are reaching out for new technologies, and start-up companies with the highest potential are being formed around novel disruptive technologies. Radical innovation creates a “gale of creative destruction” which transform industries. The identification and evaluation of technologies with high potential is today a key to success. With the decline of corporate research functions, novel technologies are increasingly sourced from other firms and universities. This course examines the overall technology commercialization process, with an emphasis on the processes by which intellectual property is protected, valued and transferred from one organization to another. The course addresses the strategic decisions involving novel technology: the identification of target markets, the economic valuation along the phases of the commercialization process and the assessment of alternative commercialization strategies including licensing, startup company formation and venture capital funding. The course is taught by a combination of lectures and real-world case studies of current technologies, primarily from the University of Rochester in science, engineering and medicine.

427. Practicum in Technology Transfer and Commercialization

Students in this course will work in the Office of Technology Transfer on projects which are a best fit to the student’s background and the range of inventions from the University of Rochester in science, engineering and medicine. Projects can include either marketing to existing companies or work on catalyzing a startup company. Either type of project will require assessments of novel concepts based on discussion with the inventors and direct market research and interactions with potential customers. The skills required are primarily those of marketing and business assessment, but some facility with technical content will be helpful. The students will prepare a technology commercialization tool or new venture plan and assist the licensing executives in the University’s Office of Technology Transfer in the negotiation process to implement the plan.

431. Legal and Tax Considerations of New Ventures  
(Same as BPP 431)

This course surveys, from the entrepreneur’s perspective, legal and tax considerations that impact strategic choices in organizing, funding, staffing, governing, and operating new ventures. The course’s principal focus is on how to create and retain competitive advantage through the skillful ordering of legal affairs. Emphasis will be transactional and include analysis of such issues as the creation and protection of intellectual property, technology licensing, global expansion, and internet commerce. The course will include, as a context for applied learning, a term project involving the creation and evolution of a selected new venture opportunity.

432. Basic Business Law  
(Same as BPP 432)

This course surveys the law of contracts, agency, and business associations – with the objective of developing familiarity with selected laws, regulations, legal principles, and legal processes that govern (a) efficient exchange, generally; and (b) how and in what ways managers and entrepreneurs organize and interact to facilitate exchange. Although emphasis will be on United States law, there will be selected reference throughout the course to issues related to international transactions and to pertinent differences in legal systems of countries outside the United States. The course has a distinct transactional focus, with heavy reliance upon contemporary cases, commercial practices, and
issues. Particular attention will be given to the impact of the legal framework upon sound managerial decision-making, business risk management, commercial rights and responsibilities, and ultimately business valuation.

435. Negotiation Theory and Practice: Bargaining for Value
This course surveys the theoretical and behavioral underpinnings of negotiation practices and develops skills that enhance the ability to capture value in cooperative and competitive bargaining scenarios. Students participate in and evaluate several cooperative and competitive negotiation simulations. Grades depend, in large part, on performance in these exercises.

441. Medical Entrepreneurship
This course aims at educating medical technology innovators how to increase their likelihood of success in identifying important clinical needs; inventing new medical practices, devices, and instruments; and transforming these advances into businesses that improve health. It covers several topics, including clinical cost effectiveness methodologies, needs finding and formulation, market analysis for biotech, patient searching strategies, and models of disease state and existing technologies. The course is unique in that it attracts both medical students and business students who are working on supervised projects together.

442A. Special Topics in Entrepreneurship: Fundamentals of Social Entrepreneurship
This course provides both an academic exploration of social impact and entrepreneurship, as well as real-world clinical projects with clients and deliverables. Readings will explore the background, overview, evolution, challenges, structures, and potentials of applying social entrepreneurial tools and attitudes to address critical societal issues, such as poverty, education, public health, and environmental threats. The role of both for-profit and not-for-profit entities will be examined. Clinical projects will address business strategies, financing, and that have clearly defined, implementable solutions for real-world problems.

442C. Special Topics in Entrepreneurship: Practicum in Urban Entrepreneurship
With the loss of vital economic drivers, Rochester is a prime example of an urban environment experiencing infrastructure distress and stagnation with a marked decrease of quality of life for its inhabitants. Like any urban environment, promoting a virtuous cycle of economic growth is vital for the recovery of Rochester. Social entrepreneurs play a critical role by engaging business tactics and an understanding of market-efficient forces that deliver savvy and creative solutions to address core urban issues, such as reducing poverty (through job creation and other means), increasing access to capital (community banking and microfinance), promoting business growth (incubators, accelerators and the role of the university), residential and retail development, effectively delivering public health services, education for its populace and future work force (i.e. Khan Academy and charter schools) and ensuring a safe and healthy environment. By encouraging new entity formation and reengineering existing organizations, these challenges create opportunities for the social entrepreneur. Understanding the fundamental pieces of the urban puzzle is essential for an urban social entrepreneur to come up with effective and relevant solutions.

442X. International Business Practicum & Israel Trek
This course aims is designed to provide students with a hands-on experiential learning opportunity regarding global entrepreneurship through a combination of lectures, a real-life business development project with an Israeli startup looking to expand their markets served by penetrating the US market and learning about the Israeli entrepreneurial ecosystem Israel has build a stellar reputation for being one of the most innovative countries in the world. It has the highest per capita number of startup companies in the world and its citizens have a perserverant, take charge approach to business, which has led a vast number of international conglomerates to base their R&D and New Product Development centers in Israel. This class will introduce students to the Israeli business culture along with multi-national corporations that based mission-critical centers there and startup venture activities in Israel. Because it is an immersive oriented program, it will introduce students to Israel’s history, which should help them understand how Israel came to be what it is today.

444. Entrepreneurial Finance
(Same as FIN 444)
Prerequisites: FIN 402
This course provides an introduction to financial theories and tools an entrepreneur needs to start, build, and harvest a successful venture. Lectures and case studies cover financial planning, business valuation (including the venture capital and the real option approach), financing, venture capital funds, compensation structures, and exit strategies.

FINANCE

402. Capital Budgeting and Corporate Objectives
This course provides an introduction to financial analysis and capital budgeting with an emphasis on the valuation of real investment projects. Topics discussed include: analysis of the firm’s choice among alternative investment projects, the term structure of interest rates, modern portfolio theory and the valuation of risky assets, the estimation of free cash flows, capital structure choices, and the cost of capital.

411. Investments
Prerequisites: GBA 412 or GBA 462 and FIN 402
Investments includes discussion of the efficient-markets theory of the dynamic behavior of prices in speculative markets, along with empirical evidence for the validity of the theory; evaluation of the implications of the efficient-markets theory for the profitability of alternative investment strategies; exploration of the implications of portfolio theory for equilibrium asset prices and the measurement of risk; emphasis on the empirical
evidence for various mean-variance and multifactor models of asset pricing and the use of these models for evaluating portfolio performance; and introduction to special topics in financial markets, such as arbitrage pricing theory, and options and futures contracts.

413. Corporate Finance
Prerequisite: FIN 402
This course provides an intensive analysis of the effects of various corporate financial policy decisions on the value of the firm, including a discussion of the effects of taxes, bankruptcy costs and agency costs on these decisions. It then examines the interrelation of financing policy with executive compensation, leasing, hedging and payout policies. The course provides an understanding of the theoretical issues involved in the choice of these policies.

418. Quantitative Finance with Python
The objective of this course is to equip you with the frameworks, tools, and methodologies necessary to build and/or be an educated user of quantitative models for financial decision making. The course is suitable for students seeking a career in finance, but also for students with broader interests who wish to strengthen their general modelling skills, and it does not require any quantitative background other than what is covered in the MBA core courses. Master modelling frameworks such as regression analysis, Monte-Carlo simulation, optimization, and binomial trees. Learn how to apply these frameworks in financial contexts such as portfolio management, term-structure estimation, capital budgeting, risk measurement, risk analysis in discounted cash flow models, and pricing of European, American, exotic, and real options. The modelling tools will be illustrated by applying them to a variety of real-world cases.

424. Options and Futures Markets
Prerequisites: FIN 402 and FIN 411
This course provides intensive study of the fundamental ideas of option-pricing theory and their application to options, financial futures and other securities; analysis of hedging with forward and futures contracts; development of the Black-Scholes option-pricing formula, its uses and modifications, and generalizations of the model; and discussion of the structure and organization of options and futures markets, and the exploration of empirical evidence on the validity of option-pricing models. Analyses of the pricing of options on futures, foreign currency, portfolios and indexes, commodity prices, bond prices, and interest rates are included as time permits.

430. Risk Management
Prerequisites: FIN 402; FIN 411 and FIN 413 (may be taken concurrently)
This course focuses on analysis of the mutual fund, investment banking, commercial banking, and insurance industries. Particular emphasis is placed on the effects of contracts and organizational structure on the incentives of the participants in these industries.

433. Cases in Finance
Prerequisites: FIN 402 and FIN 413
This course provides intensive exercise in valuation methods and the economic analysis of problems of corporate financial policy. A variety of other topics, including insider trading, portfolio performance and asset allocation, are also explored. Specific case topics include: corporate valuations; M&A transactions (tender offers, mergers, proxy fights); recapitalizations; stock repurchases; and novel securities. Case reports are done in teams and judged on clarity and usefulness to practitioners in understanding and resolving strategic problems.

434. Investment Management and Trading Strategies
Prerequisite: FIN 411
This course explores selected topics in the management of equity portfolios. Course content may vary from year to year. Topics include: active portfolio management with particular emphasis on risk analysis, multifactor risk / return models and performance evaluation and style analysis. The course also considers issues and evidence on different forms of market structure and trading systems, including the role of specialists/dealers, optimal trading behavior for institutions, price impact of trades, and related information technology. Extensive use is made of investment software.

441. Special Topics in Finance
(Not offered every year)
Prerequisite: Established by the instructor
Special topics are generally those which are not well covered in other courses. The specific content varies, depending on faculty interest.

441A. Special Topics in Finance: Real Estate
This course provides an introduction to, and an overview of, real estate as a capital asset and as a major component of our financial markets. The course will focus on the basic economics of real estate markets, market analysis, and real estate finance. Concepts used in the real estate industry will be covered throughout the course. The course will specifically consider market analysis, valuation, capital structure, and risk analyses for income-producing (commercial) properties. The securitization of both commercial and residential properties has been a critical factor in our current economy, and the structure of real estate securities and investment vehicles such as real estate investment trusts will be studied. The course also introduces real estate development and current trends in the market.

441B. Special Topics in Finance: Private Equity
The Private Equity and Venture Capital [PE/VC] industry is now more in the popular press than ever before; funds are larger and more diverse than in any past generation, deals are bigger, scope is worldwide, and wealth-generation seems to be at levels heretofore unseen. Many argue that PE/VC drives major segments of national economies more than ever before, and that it is essential that the industry is better understood and weighed more heavily
in the thinking and plans of policy-makers in government and commerce. This course provides exposure to what PE/VC is and how it works. We cover, among other things; the make-up of funds, the composition and operation of PE/VC firms, dealing sourcing, due diligence and investment process, and the roles of partnerships, GPs, LPs, ‘activists’ and Boards. At a higher level, we cover industry performance and competition, fund creation, some international aspects of the business, and differing approaches to financing in different alternative asset categories.

442. International Economics and Finance (Same as BPP 442)
Prerequisite: FIN 402
Recommended: FIN 411

Topics include: exchange-rate regimes; the determination of exchange rates in a world of flexible exchange rates; speculation in foreign exchange markets; the Eurocurrency and measurement of foreign exchange exposure; analysis of currency forward, future, option, bond, and swap contracts; hedging of foreign exchange exposure.

444. Entrepreneurial Finance (Same as ENT 444)
Prerequisites: FIN 402

This course provides an introduction to financial theories and tools an entrepreneur needs to start, build and harvest a successful venture. Cases and lectures will cover business evaluation and valuation, including the venture capital and the real option approach, financing, venture capital funds, compensation structures, and exit strategies.

446. Financial Information Systems (Same as CIS 446)
Prerequisites: CIS 401 and FIN 402

This course examines the role that information systems and telecommunications play in various aspects of financial markets, financial service organizations, and corporate finance. Technology’s transformation of financial markets is studied from the perspectives of electronic trading systems competing with exchanges; Internet brokerage firms attracting trading and IPO’s and making markets; firms supplying company and market information, managing risk, and providing custodial and management services. The course covers financial services issues such as electronic banking, automated personal financial management, electronic payment systems, and digital cash. Case studies are used in many classes.

448. Fixed-Income Securities
Prerequisites: FIN 402 and FIN 411

The objective of this course is to undertake a rigorous study of fixed-income securities and markets. A variety of fixed-income securities will be discussed including coupon bonds, callable and puttable bonds, sinking fund provisions, and floating rate notes. Interest rate derivatives such as forwards and futures on fixed-income securities, bond options, options on bond futures, caps, floors, and collars will also be discussed. In addition, we will study some tools that are useful in bond portfolio management including horizon analysis, duration, optimization techniques for constructing bond portfolios and modes for pricing fixed-income securities. While the perspective of this course is from the viewpoint of a bond investor, a person in corporate finance needs to understand similar material. Evaluating an investment in a fixed-income security is the mirror image of the problem faced by a corporation in deciding whether or not to issue a bond.

462. Foundations in Financial Economics

This course serves as an introduction to the theory and practice of corporate finance. It provides a market-oriented framework for analyzing the investment and financing decisions made by corporations. The two major questions, which this course aims to answer, are: 1) How do corporate managers decide which projects to undertake? and 2) How do they decide how to finance these projects? Topics discussed include valuation of financial assets, capital budgeting techniques, theories of capital structure, and capital market efficiency.

465 A/B. Applied Finance Project I & II

The experience of working on actual projects provides the opportunity for the student to incorporate subjects, skills and tools, introduced through the classroom, into the problem identification, assessment, and solution process used with and for clients. The project work also provides visibility and use of measurement schemes, statistical analysis, and engages the student in activity that supports the development and use of business judgment; skills and perspective driven by practice, with consequences associated with results - as they hear frequently in the courses they take. The projects offer visibility to varied management processes, internal and external political processes, and continually provides emphasis on measurable results - not simply activity. This course integrates and expands classroom education with ‘real-world’ experience - providing opportunities for, among other things; project management; process management; task planning; testing and use of class concepts/tools in an actual work environment; focus on results, not simply activity, business planning; performance planning and management; inter/intra group collaborative efforts on goal-oriented work activity; business assessment; development/practice/testing of business judgment; organizational and functional assessments, management and personnel assessment; time management; measurements of ‘value-added’ and ‘effectiveness’ in consultative roles in widely-varied organizations; goal, task, and process negotiations; expectation development and communication; feedback development; and planning and coaching through change processes.

505. Theory of Finance

The goal of this course is to present the theory of asset pricing and portfolio selection in multi-period settings under uncertainty. The asset pricing results are based on three increasingly restrictive assumptions: single-agent optimality, absence of arbitrage and equilibrium. These results are unified with two key
511. Continuous Time Theory in Finance

The course builds on the basic theory presented in FIN 505 Theory of Finance. FIN 511 will emphasize some relatively advanced mathematical methods that are used in the research literature of financial economics. The objective of the course is to provide the student with enough knowledge of these methods that he or she can begin to use them in nontrivial ways in his or her research. Particular emphasis is given to topics that are costly or difficult to learn on an individual basis. The methods surveyed in the course are primarily techniques for constructing and analyzing continuous-time models of trading and of stochastic asset price behavior. Virtually all of the derivative security pricing models and many of the multifactor models of asset prices and the term structure of interest rates are of this type.

514. Empirical Corporate

This course covers cross-sectional and panel data empirical methods used in corporate finance research. The course will expose students to a variety of methods commonly employed in empirical research. While the course will cover the efficiency and consistency of various estimators, the primary focus will be on how econometric tools can be used to identify unbiased causal effects. Lectures and econometric readings will provide students with econometric intuition behind each method covered in the course. Course readings will expose students to examples of the methods being used in published and working papers. Assignments will familiarize students with standard datasets used in corporate finance and will enable students to apply the methods covered in the course and to analyze and criticize other researchers’ use of common empirical methods.

523. Advanced Agency Theory

The course studies dynamic aspects of the theory of the firm. The strong emphasis is placed on the role of time and repeated decisions in firm management. The topics include real options, dynamic lemons markets, dynamic contracts, and investment under constraints. The course is research intensive, requiring completion of several referee reports and a term project.

524. Empirical Asset Pricing

This course covers classic contributions and recent developments in capital markets research, both applied theoretical and empirical, in relation to corporate policies, business cycle and economic growth. Specific topics include time-series predictability of stock market returns, empirical methods and evidence on the cross-section of returns, evidence on mutual fund performance and the closed-end fund puzzle, event studies and the empirical relations between stock returns and corporate policies, consumption-based asset pricing, applied equilibrium modeling of asset pricing anomalies and behavioral finance.
presentation of final recommendations; and reflection upon the overall experience.

411. Business Modeling
This course has two major objectives: to develop the ability to frame business decision problems in a way that makes them amenable to quantitative analysis and to train in fundamental quantitative analysis techniques useful for business problems. The course is structured in three parts: 1. using spreadsheets to model business decision problems. 2. solving complex decision problems involving many variables and constraints. 3. Monte Carlo simulation is introduced as a framework for understanding and analyzing uncertainty in business. Examples from different functional areas will demonstrate how the techniques taught can be applied in a practical way to a variety of settings.

412. Data Analytics
This course provides an introduction to utilizing data and data analytics to inform decision-making. Extracting information from data has become an integral part of modern business management, from sports teams, to Wall Street, to Silicon Valley. GBA 412 will de-mystify statistics, enabling students to thrive in a competitive market for data-based decision-making. After building core statistical and decision theoretic tools, this course will introduce you to different types of data and provide you with a set of analytical methods that apply to each. We introduce basic notions of probability and randomness, transition to data visualization techniques, and conclude with the basis of modern data science: prediction and multiple regression. Connections to other Simon classes will be emphasized, as will a hands-on approach to data analysis (laptop computers are required for every class). In the process, students learn to ask the right questions, seek out the relevant data, apply appropriate methods, and effectively communicate your insights to your target audience.

419A/B. Leading Teams I and II
This sequence of courses spans fall and winter quarters and prepares Simon MBA Coaches and Workshop leaders to lead 1st project teams and problem solving groups in areas of setting expectations; establishing process; employing collaborative problem-solving frameworks; managing conflict; and giving and receiving performance feedback. The course rests on theoretical frameworks from the fields of education, psychology, and communication; its focus is the practical application of these concepts to facilitate the successful functioning of team-based problem solving and project management groups. The course provides weekly opportunity to review Workshop and Coach meeting related issues. Workshop leaders increase their mastery of business modeling and operations management concepts, and coaches improve their skills in developing presentations, managing projects and giving feedback for improved performance.

435. Negotiation Theory & Practice: Bargaining for Value
The course is subtitled “Bargaining for Value” because the notion of “bargaining” implies interaction and communication among self-interested players of diverse backgrounds and styles. “Bargaining for value” implies that the quantum of value extracted in a deal may vary within a range of potential values. “Negotiation” is a commonly-accepted term that captures the essence of these processes in a competitive or cooperative environment. This course surveys the theoretical and behavioral underpinnings of negotiation practices and develops skills that enhance the ability to capture value in cooperative and competitive bargaining scenarios.

441. Business Ethics
This course deals with business ethics and the social responsibility of business organizations. It is designed to inform decision-making about ethical challenges arising in business. It helps students identify and manage difficult ethical dilemmas they are likely to encounter in their future careers. The course is organized into four parts. It begins by looking at the place of business ethics in a competitive economy and discussing fundamental questions about the ethical responsibility of business corporations. Next, it addresses ethical issues faced by individuals in business organizations, including the complex nature of managerial responsibilities, whistle-blowing, and insider trading. It also explores the responsibilities of business corporations vis-à-vis clients, customers, and employees, discussing issues such as professional conflicts of interest in financial services, information disclosure in advertising, fairness in sales practices and in hiring and treating employees. Finally, it analyzes some ethical questions specific to business decisions in the health sector.

461. Core Economics for MS Students
This course covers the fundamentals of economic theory, and discusses marketing-relevant applications. Specific concepts include understanding demand and demand elasticity, marginal revenue, key cost concepts (fixed costs, variable costs, marginal costs, sunk costs), profit maximization, understanding the competitive environment and strategic decision making, and net present value calculations.

462. Core Statistics for MS Students
This course equips MS students with statistical skills necessary for data-driven decision making. The course covers central tendency and variability, probability, binomial and normal distributions, standard scores, hypothesis testing, z and t tests, ANOVA, correlation and regression, and non-parametric tests.

463. Economics and Marketing Strategy for MS Students
This course introduces students to the basics of economics and marketing strategy through interactive lectures and case discussions. Consumer choice, demand curves, the impact of competition and costs form the nucleus of the economics topics. Marketing strategy builds on these consumer, competition and company considerations to understand the segmentation, targeting, positioning and promotional decisions of the firm.
464. Programming for Analytics

This course provides a foundation in programming within the R environment. Traditional programming concepts—operators, data structures, control structures, repetition, user-defined functions, and scoping—will be central to the learning objectives, but the concepts will be taught in context of marketing and business analytics problems related to data management and visualization. In addition to high-level programming, the students will gain a foundational understanding of how data is organized and pulled from databases, including the querying process that turns raw data into the kinds of datasets that more advanced analytics tools leverage. In the process, students will learn rudimentary SQL and the related core concepts (e.g., aggregation and joins). The course involves hands-on tutorial assignments involving practical pattern matching as well as less structured programming assignments, where the students are expected to write their own programs.

466. Accounting and Finance for MS Students

This course presents the basics of financial accounting, and will provide a framework for analyzing financial data, and understanding concepts developed throughout subsequent courses in the Business Analytics program. The course begins with an overview of the four financial statements, and then advances to more in depth coverage of Revenue and Expenses, Assets, Liabilities, Stockholder’s Equity, and Cash Flow. The course will then survey topics in corporate finance, centered on the analysis of financial data. The course includes a survey of financial metrics used to analyze operations, then proceeds to a discussion of project evaluation with a focus on relevant cash flows, and then finishes with a discussion of the appropriate required rate of return to be used in evaluating those cash flows.

484A/B. Simon School Venture Fund Practicum I & II

This course is a 1-credit practicum for 1st-year MBA and MS students who are accepted by the Management Team of the Simon Venture Fund (SVF) as an analyst. Students receive 1 credit in their first year for successful participation as analysts, registering in the Winter of their first year, and receiving a grade of Incomplete until their commitments to the Fund are completed in the Spring. Students returning for a second year at Simon, that are accepted into the Management Team of the SVF by the SVF Board, may then register for a 2-credit SVF Practicum in the Fall of their 2nd year to complete the sequence, receiving a grade of Incomplete until their Fund commitments are completed in the following Spring. The purpose of this practicum is to recognize and support the effective analysis and portfolio management functions of the SVF throughout the academic year. Instructor interaction with students is primarily advisory and ad hoc. 1st years primary contacts, training, evaluation and performance coordinators will be the SVF Student Management Team. The SVF provides an environment where students can practice applying theories and skills acquired throughout the MBA and MS curriculums to such matters as venture capital fund operations; early stage business analysis; deal structure; and funding considerations faced by startups seeking capital investments.

486. Management of Technology

Prerequisite: completion of core courses

This capstone course focuses on the strategies of international corporations that seek a sustainable competitive advantage through technological innovation. Instruction consists of lectures, guest speakers from the business community and case presentations. Topics include: the definition of corporate strategy; the C.E.O.’s role as leader as well as manager; the analysis of the firm’s competitive position; the development of the firm’s core competencies; the management of research and development; fast-cycle product development; cross-functional teams; achieving product quality through technology; a comparative analysis of patent law in the U.S. and other countries; structuring strategic alliances between large and small firms; international joint ventures; and the acquisition of small, high-tech firms by large corporations. Student teams play the role of principals in a management consulting firm (“Simon Associates”) that has been retained by the CEO of a technology-based corporation to develop strategic options and recommendations for the solution of a complex business problem with marketing, operations and financial implications. Oral presentations, management memos and written reports are graded on the clarity of presentation as well as the quality of analysis.

490. American Business Practice

Credit—one hour

Prerequisite: completion of all core courses

This course is designed to give non-U.S. students an opportunity to apply business-management theories they have learned in their Simon School studies while they are assigned as interns (minimum of six weeks) with U.S. companies. Internships allow students to work in business settings/situations in which they receive on-the-job training from management personnel and gain valuable practical experience in performing professional-level tasks in their area(s) of concentration. GBA 490, which cannot be used to complete a concentration in the MBA program, is open only to non-U.S. students who are eligible to work in the United States. An eligible student, as defined by immigration regulations, is a degree candidate who has lawfully resided in the United States on visa status for at least one academic year (eight to nine months) prior to starting an internship position. Students who plan to enroll in GBA 490 must communicate with the University of Rochester’s International Services Office (ISO) regarding the submission of proper documentation for employment. They should inform Simon School Career Management of their plans to seek a business internship, and they should schedule an appointment with Career Management to discuss
career interests and employment-search strategies. When/if an internship is obtained, the student must meet with a GBA 490 faculty advisor to prepare a proposal describing the location and nature of the assignment and the planned functional area of study. The proposal, which will include specific learning objectives, must be approved by the faculty advisor prior to the student’s acceptance of the internship. Upon completion of the internship assignment, the student must prepare a 10- to 12-page report detailing its outcome(s) and stating whether the proposed learning objectives were met.

490E. Integrating Business Theory and Practice
Credit—one hour

This course is designed to give students an opportunity to apply business-management theories they have learned in their Simon School studies while they are assigned as unpaid interns. These unpaid internships allow students to work in business settings and situations in which they receive on-the-job training from management personnel and gain valuable practical experience in performing professional-level tasks in their area(s) of concentration.

491. Reading Course
(Offered at the discretion of individual faculty)

Supervised reading and study on topics beyond those covered in existing formal courses.

493. International ExChange Program

The Simon Business School offers International Exchange Programs to provide experience abroad to second year MBA students anticipating careers with an international focus. Students who participate in the program can receive up to nine hours of credit toward their Simon M.B.A. program. Students whose GPA is 3.0 or higher may apply to spend one quarter of their second year at one of the Simon partner schools. Students will take classes with native students as well as students from around the world. The program provides the opportunity to live and study in a foreign country, to further develop language skills and to increase students’ multicultural awareness. All courses must be approved before departure (or once the schedule for partner school is available). In general, courses transferred count as unrestricted electives.

494. Foreign Language Transfer Credit
Credit—three hours

591. PhD Reading Course

594. PhD Independent Study

595. PhD Research

995. Continuation of Doctoral Enrollment

999. Writing Dissertation

HEALTH SCIENCES MANAGEMENT

420. Business Economics of the Health Care Industry

HSM 420 uses the tools of managerial economics (such as cost-benefit analysis, organizational architecture, and the role of incentives) to analyze the business institutions, practices, and regulation of the health care industry. The course covers the health care value chain including: i) purchasers of health care services (e.g., government, private insurers, and employers); ii) providers of health care services (e.g., hospitals and physicians); and iii) manufacturers of medical devices, pharmaceuticals, and supplies. We seek to understand: the US healthcare system in an international context; the role technology plays in driving change in the industry; the fiscal crises that have spurred health care reform; how health care providers have used mergers, product line management, and information technology to address contemporary management challenges; the next stages in the evolution of managed care as embodied in Accountable Care Organizations and consumer-driven health care; important trends in health care delivery including quality measurement and reward, disease management, and pay-for-performance; and the adoption and financing of medical technology by health care organizations.

425. Managerial Accounting for Health Care Organizations
(Same as ACC 445)

Costs for health services continue to rise faster than overall economic growth drawing ever-greater attention from employers, governments, and consumers. The front line of the cost battle is within the health services entities where decision-making depends on accurate reporting of internal costs. This course allows the students to understand how costs are reported and how to use this information to make decisions within the health services entity. The following topics will be examined within a health services setting: cost allocation, cost-volume-profit analysis, budgeting and variance analysis, and transfer pricing.

430. Health Sciences Management and Strategy
(Same as STR 430)
Prerequisite: STR 401 or GBA 461
Recommended: STR 403, STR 42

This course applies the principles of organizational economics and strategy to the institutional setting of the health sciences. The course focuses on the interdependence between the delivery, financing, and technology sectors of the health care marketplace. It discusses how management and strategy choices within each sector are responses to the unique institutional factors in the health care marketplace and how the strategies of each sector affect the behavior of the others.
**431. Applications of Corporate Finance and Governance to Health Care**  
Prerequisites: STR 403, ACC 410. In addition, it is strongly recommended that students complete FIN 413 and HSM 430 before taking this course.

This course applies the principles of corporate finance and governance to the institutional setting of health care. It draws on the principles of financial valuation, investments and corporate financing, as well as the economics of organizations and corporate governance, to analyze current management problems in the health care sector. The primary purpose of the course is to gain an understanding and comfort level with applying economic and financial theories within the unique institutional setting of health care.

**437. Managing Health Care Operations**  
(Same as OMG 437)

The health care industry is undergoing rapid growth as well as rapid structural changes. New technology, changing reimbursement mechanisms, and increased competition create many interesting management problems, least of which is in the area of health care operations. In this course, we will study the operations of various types of health care provider organizations (such as hospitals, HMO’s, group practices, nursing homes, etc.) and other participants in the industry (such as insurance companies, pharmaceutical companies, suppliers and consulting companies). Topics that will be studied include: patient and provider scheduling, capacity management, providing services and supplies to health care providers, new product development and integrated delivery systems. Students who took OMG 402 or similar need to obtain instructor’s permission prior to registration.

**440. Evolving Medical Markets**

Firms supplying products and services to the health care industry face a variety of regulatory and marketing challenges that will be explored in this course. Topics include: the economics of developing and marketing new medical technologies, regulations affecting market structure, health and safety regulations and insurance markets. The course will cover evaluation tools frequently used in public policy debates and in marketing medical technologies including cost-benefit and cost-effectiveness analysis and quality of life indices.

**450. Accounting, Economics and Finance for MS Students**  
Available only to MS students concentrating in Marketing and Health Sciences Management

This course is designed to present the fundamentals of economic analysis, financial accounting, and financial analysis that will serve as a foundation for concepts developed throughout subsequent courses in the Medical Management program. The objectives of this course are to enable participants to understand and productively use the principles of managerial economics and accounting information to better structure business decisions. In addition, the course will address the principles of capital budgeting. The economics section covers foundational principles of microeconomics. The focus is on those principles with the greatest application for managers in health care, including supply and demand, the economic model of behavior, decision-making under uncertainty, gains from trade, externalities, demand, production, and cost functions, and basics of pricing. The accounting and finance module presents skills required to interpret and analyze common financial statements, and evaluate a company’s past performance and potential future performance. Specific topics of discussion include differences in financial statements of for-profit vs. not-for-profit entities, cash vs. accrual accounting, depreciation methodologies, and capital budgeting. Capital budgeting will include net present value (NPV), pay-back, accounting rate of return (ARR) and internal rate of return (IRR).

**451. Health Care Strategy and Business Plan Development**

Basic marketing and economic concepts are integrated with the unique institutional features of health care markets to develop a framework for strategic and business planning for a health care organization. A special focus is placed on the practical elements of plan development.

**452. Health Care Accounting and Finance**

Basic concepts in finance and financial accounting are combined with material developed in ACC 410 to develop a framework for financial decision making, financial planning, assessment, and control. The goal of the class is to provide students with a set of tools to first make financial decisions about programmatic development. In addition, students will be taught to assess and control programs toward specified financial goals.

**453. Health Care Operations**

This is an advanced course on operations management for health delivery organizations. We study the application of operations management concepts to the management of health care provider organizations (such as hospitals, group practices, HMO’s, nursing homes, etc.), and other participants in the health industry (such as insurance companies, pharmaceutical companies, consulting businesses, etc.). Applications include both medical and administrative operations. The course uses a mixture of cases, lectures, in-class exercises, and guest lecturers. Part of this course is closely integrated with OMG 402, Operations Management extending and applying concepts from the introductory course to practical problems in health care administration. However, a significant part of the course focuses on quality and process improvement, a topic that is not covered in OMG 402.

**454. Leading Health Care Organizations**

Concepts developed in STR 401 Organizations and Strategy are applied within the evolving healthcare setting to teach the student how to organize tasks and motivate staff to achieve coordination and efficiency (including leadership, culture, change management, and team effectiveness).
455. Health Care Practicum I
This course provides students with hands-on experience with a medical management project. It develops skills in identifying a problem, working with data, finding possible solutions and delivering recommendations, all within a fixed time frame. Students learn to produce analysis, but also have to argue persuasively that the recommendations based on the analysis are valuable and should be implemented. Projects require that students not only apply analyses learned in the classroom, but also that they argue persuasively that the recommendations based on the analyses are valuable and should be implemented. Teams of three to four students are responsible for the individual projects, and meet with the instructor individually. The organizations submitting projects must be willing to spend time with students and to provide appropriate data.

456. Health Care Practicum II
Prerequisite: HSM 455
A continuation of the project from HSM 455.

464. Creating and Using Information to Manage Health Care
The objective of this course is to provide health care executives with an understanding of the role that Information Technologies can play in driving care quality and financial performance in their organizations. It is intended to improve their ability to invest strategically and thoughtfully in IT to achieve the desired organizational returns. The course discusses how information technologies are reshaping and redefining the healthcare sector through better care, efficiencies in the delivery of care, advanced tools for patient involvement and continuum of care, decision support tools for clinicians, and the generation of insight from digital exhaust. It teaches students how to critique and analyze various technology tools and systems currently available to health care professionals. The focus is largely on strategic level issues, although some implementation issues will also be discussed.

MANAGEMENT SCIENCE METHODS

400. Mathematics Review
Non-credit
Review of mathematical concepts prerequisite to the MBA program. Topics include: sets, vectors and matrices, functions and relations, linear equations, laws of exponents, limits and continuity, differentiation, maxima-minima, partial derivatives and simple integration.

491. Math for Management
Credit—two hours
This is a master’s level math class that is more intensive than MSM 400. Analysis and concepts in modern business analysis rely heavily on quantitative methods. Necessary theories and intuition behind them will be covered. The focus of the course is primarily on applications in business, economics and related areas.

501. Quantitative Methods Colloquium
Non-credit
This is a forum for the presentation of on-going and recently completed work by students, faculty, and guest lecturers.

502. Linear Algebra
The goal of this course is to give an introduction to linear algebra. Topics include: Gaussian elimination, matrix operations, matrix inverses. Vector spaces and subspaces, linear independence, and the basis of a space. Row space and column space of a matrix, fundamental theorem of linear algebra, linear transformations. Orthogonal vectors and subspaces, orthogonal bases, and Gram-Schmidt method. Orthogonal projections, linear regression. Determinants: how to calculate them, properties, and applications. Calculating eigenvectors and eigenvalues, basic properties. Matrix diagonalization, application to difference equations and differential equations. Positive definite matrices, tests for positive definiteness, singular value decomposition. Classification of states, transience and recurrence, classes of states. Absorption, expected reward. Stationary and limiting distributions. Offered in the summer, primarily for entering doctoral students.

503. Optimization
This course covers Optimization in Rn, Weierstrass Theorem, Unconstrained optimization, Lagrange Theorem and equality constraints, Kuhn-Tucker Theorem and Inequality constraints, Convexity, Parametric Monotonicity and Supermodularity. Offered in the summer, primarily for entering doctoral students.

504. Theory of Probability and Stochastic Processes I
Prerequisite: Some knowledge of functions of a real variable (MTH 265) and probability (BST 401)
The course provides an introduction to stochastic processes. Topics include the Poisson process, renewal theory, Markov chains, semi-Markov and Markov renewal processes, and regenerative processes.

505. Theory Of Probability And Stochastic Processes II
This course covers Optimization in Rn, Weierstrass Theorem, Unconstrained optimization, Lagrange Theorem and equality constraints, Kuhn-Tucker Theorem and Inequality constraints, Convexity, Parametric Monotonicity and Supermodularity. Offered in the summer, primarily for entering doctoral students.

506. Management Science Methods
The purpose of this course is to introduce PhD students to a variety of operations research and management science methods in an applied setting to develop their modeling abilities. The emphasis of the course is on defining problems, building models, and analyzing the models to gain some insight, in other words, critical research skills. This course will draw upon both deterministic optimization methods and stochastic models but not their theory. These will include linear programming including integer and network formulations, basic queueing models (M/M/1, M/M/n, M/G/1), and Monte Carlo simulation.
509. Informational Sciences and Large-Scale Algorithms
Prerequisite: MSM 535 or permission of the instructor

This course examines recent methodological and modeling advances for solving large business problems. It includes summaries of numerical analysis techniques, artificial intelligence and heuristic optimization techniques (neural networks, genetic algorithms, tabu search and simulated annealing), and modeling techniques (decomposition, aggregation, scaling and dimensional analysis). The advances in optimization techniques include primal and dual decomposition, distributed algorithms, various projection and relaxation approaches, inner and outer linearization, aggregation and bounds.

522. Optimization
Prerequisite: Some knowledge of linear algebra and functions of a real variable

This course introduces unconstrained and constrained optimization in finite dimensional spaces. Topics include convex sets and functions, Kuhn-Tucker theory, Lagrangian duality, parametric continuity, dynamic programming, and parametric monotonicity.

533. Dynamic Programming
Prerequisite: MSM 522

Dynamic Programming (DP) is a recursive approach to obtaining optimal solutions to sequential decision problems. DP can be used for either finite-horizon or infinite-horizon problems, and is applicable to both deterministic and stochastic problems. This course will explore both theoretical and computational aspects of DP.

535. Network and Integer Programming

This course covers the solution of network problems and integer programs. Shortest path, minimum spanning tree, maximum flow, minimum-cost flow, and matching are some of the network problems covered. Algorithms for linear-integer and mixed-integer problems include branch and bound, implicit enumeration, primal and dual-cutting planes, group theoretic methods, Lagrangian relaxation and surrogate relaxation. These algorithms are illustrated on classical integer problems such as the knapsack, set covering/partitioning and traveling salesman.

542. Queueing Theory and Applications
Prerequisite: MSM 504 or Medical School course BST 402, or permission of the instructor

The course offers in-depth study of queues and networks of queues, including single- and multiserver-queues; Markovian models of phase-type systems; open-and-closed networks of queues; product-form solutions and local balance; bottleneck-analysis approximations and computational aspects. It also covers applications to scheduling, resource allocation and capacity-expansion decisions in service systems, computer systems and job shops.

549. Markov Decision Processes
Prerequisites: MSM 504 and MSM 505 or equivalent.

This course is as an introduction to sequential decision-making and it reviews the theoretical foundations of dynamic programming, stochastic control, and Markov decision processes. Much of the course is devoted to the theoretical, modeling, and computational aspects of Markov decision processes. Applications in the area of production and inventory, finance, and marketing are explored.

MARKETING

402. Marketing Management
Prerequisites: STR 401 or GBA 461 and GBA 412 or GBA 462 (may be taken concurrently)

This course is our introduction to marketing. The viewpoint is that of a manager making marketing decisions in a variety of competitive and institutional settings. Considered are: consumer behavior, marketing research, product design, advertising, sales-force management, pricing and distribution channels.

412. Marketing Research
Prerequisites: MKT 402 and GBA 412 or GBA 462

This course deals with the collection and use of data to support marketing decisions. The first part of the course teaches the student how to formulate the research problem, design the research and collect the data. Among the data-collection techniques discussed are: questionnaire design; telephone, mail and electronic surveys; and laboratory and field experiments. The second part of the course examines various techniques for analyzing data: cross-classification analysis, factor analysis, multidimensional scaling, conjoint analysis, etc. As part of the course requirements, teams of students design, administer, analyze and report on an actual marketing-research study.

414. Pricing Policies
(Same as STR 423)
Prerequisites: STR 401 and MKT 402 (may be taken concurrently)

Pricing is one of the most important, least understood, and most controversial decisions a manager has to make. These decisions often have significant long-term implications for a firm’s bottom line. The purpose of this course is to help future managers make good decisions by preparing them to analyze the environment in which their firm operates and to arrive at an appropriate pricing policy for their product or service. More specifically, the objectives of the course are: 1) to develop an understanding of the relationship between a firm’s environment (e.g., cost, demand, competition, and legal aspects) and its optimal pricing strategy, and 2) to develop skills in applying this understanding. There are several components to the course: elasticity of demand and relevant costs, price discrimination and market segmentation, and competitive pricing. Students will learn the fundamentals of economic-value analysis and break-even analysis, and will be made familiar with strategies such as bundling, tie-in sales, quantity discounts, product-line pricing, and demand buildup.
The course will cover ways of predicting competitor-pricing responses, and it will discuss a firm’s legal environment as it pertains to pricing.

431. Consumer Behavior  
Prerequisite: MKT 402  
The course studies buyer behavior in consumer and industrial markets. Topics include: culture, social class, consumer involvement, motivation, knowledge, attitudes and group decision making. Besides theory, the course also covers applications to product, advertising and pricing decisions.

432. New Product Strategy  
Prerequisites: MKT 402 and GBA 412 or GBA 462  
This course examines the issues involved in the planning and introduction of new brands and the management of existing brands. The approach taken is analytical and consistent with some of the more up-to-date methods used by companies. The course starts by examining the product class in which the firm is considering either repositioning an existing brand or introducing a new brand. We study how consumers choose a brand within the product class. This includes the theory and estimation of the multi-attribute utility model. Leading on from this, we study how to reposition an existing brand and optimally design a new brand or a line of brands. Procedures for lab and market testing of a new brand are reviewed. We proceed by evaluating the current and future sale of the product class through the diffusion model. A discussion is held on the marketing mix policies for brands over the product life cycle. The course concludes with an evaluation of the portfolio of product classes in which the firm ought to compete. A group project involving the development of a marketing strategy for an existing brand with emphasis on its repositioning is required.

433. Advertising Strategy  
Prerequisite: MKT 402  
This course explores the tools available to marketers for the promotion of products and services. The integrated marketing communications philosophy is stressed, and principles of consumer behavior are discussed as the starting point for the analysis of promotion decisions. Advertising is the main focus of the class, and issues such as the setting of campaign objectives, segmentation and targeting, budgeting, media placement, message strategy, creative development, persuasion and measurement of advertising effectiveness are discussed. More specialized units consider Internet and global/cross-cultural advertising. Sales promotion techniques are also discussed, including consumer promotions (e.g., sampling, coupons, premiums, contests) and trade promotions (e.g., buying allowances, cooperative advertising). Other elements of promotion discussed include public relations, sponsorships and personal selling.

435. Channels Strategy  
Prerequisite: MKT 402  
This course deals with the issues that arise in designing and managing distribution channels and salesforces. A central theme of the course is that these entities perform both a tactical/operational function as well as a strategic function and that both aspects need to be considered in their design and management. The course looks at a number of design options, ranging from direct distribution through a salesforce to a complex, multi-layered channel consisting of several layers of intermediaries such as wholesalers and retailers. Managing a channel requires an understanding of the competitive and cooperative aspects of manufacturer-distributor relationships. The course evaluates the efficiency of contractual arrangements like exclusive territories, exclusive dealing requirements and resale-price maintenance from the manufacturer’s and the distributor’s point of view. Finally, an assortment of contemporary issues in channels—such as everyday low pricing versus promotional pricing, slotting allowances, the shift in bargaining power from manufacturers to retailers for consumer goods, growth of store-labeled brands, the role of the Internet and new forms of retailing—are discussed. In addition, a number of modeling and quantitative techniques are studied that help implement the strategies discussed in the course. On the salesforce front, the course delves into a number of critical issues such as performance measurement, territory decision, quotas and compensation design.

436. Marketing Analytics  
Firms can now gather detailed real-world data on their customers, competitors and marketplace on an unprecedented scale. This volume of information will provide significant competitive advantages to those companies that are able to analyze and leverage these data sets to derive actionable business-building insights. This course will focus on what datasets, both big and small, can and cannot tell us. This analysis, however, requires a different toolset, and a different mindset than traditional survey data analysis. The tools and metrics of three kinds of data analysis will be covered: predictive, explanatory, and causal. Students will be introduced to basic programming through R, a widely used and state of the art statistical analysis software which is constantly updated. Students will learn how to prepare their data for analysis, and to then turn these results into actionable insights.

436R. Marketing Analytics Using R  
Firms can now gather detailed real-world data on their customers, competitors and marketplace on an unprecedented scale. This volume of information will provide significant competitive advantages to those companies that are able to analyze and leverage these data sets to derive actionable business-building insights. This course will focus on what datasets, both big and small, can and cannot tell us. This analysis, however, requires a different toolset, and a different mindset than traditional survey data analysis. The tools and metrics of three kinds of data analysis will be covered: predictive, explanatory, and causal. These analyses require the use of modern programming languages due to their
flexibility, and their ability to scale to large-scale and complex data sets. The course therefore expands students' knowledge of R, a widely used, multipurpose language. Students can also use RStudio¹, which provides a more user-friendly interface to this language.

437. Digital Marketing Strategy (Same as CIS 437)  
Prerequisite: MKT 402

This course examines the major issues involved in marketing on the Internet. Among the topics studied are: new product opportunities on the Internet; the changed role of advertising; the Internet as a two-way communication medium between consumers; targeting individual consumers; word-of-mouth among consumers on the Internet; the Internet as a distribution channel; and marketing research on the Internet.

438. B2B Pricing  
(Same as STR 438)

Students will learn the major differences in pricing strategies between selling to consumers (as in MKT 414/STR 423) and to other firms which then deal with consumers. The course starts by analyzing the pricing problem of a manufacturer selling to a retailer. We examine the issue of double marginalization, and learn how two-part tariffs get us out of this problem. We also examine different forms of contractual relations—from vertical acquisitions to regular short-term contracts—and potential issues with every form, touching on transfer pricing and outsourcing. In the second part of the course, we analyze a crucial concept of cost pass-through (how much a retailer should decrease the retail price in response to a decrease in the wholesale price) and the effect of manufacturer’s advertising on the retailer and on the channel overall. This course is a natural continuation of Pricing for those who are interested in working in an industry where a significant portion of sales is done through independently-owned retailers, whether students are planning on working on the retailer side or on the manufacturer side of this industry.

439. Advanced Pricing  
(Same as STR 439)  
Prerequisite: STR 423 or MKT 414

This course builds on MKT 414/STR 423 to equip students with the necessary skills to make profitable pricing decisions in complex business environments. Topics include: pricing with constrained supply, pricing in the presence of uncertainty about demand, markdown management, advance selling, pricing on the Internet, pricing in the presence of direct or indirect network effects, selling through auctions, and behavioral and ethical aspects of pricing. The course also includes a comprehensive pricing simulation.

440. Pricing Analytics  
Prerequisite: MKT 436

The objective of this course is to prepare students for the intuition and tools to make pricing recommendations in a variety of industrial contexts, and to meet the booming demand in pricing and consulting related careers. The course builds around key economic intuitions behind customer- and competition-driven pricing strategies, and focuses on the application of these strategies to a variety of pricing problems using state-of-the-art data analysis toolkit. We primarily study the decisions on price levels, and changes of prices along time, product line, market segments and competitor structure. We also explore synergies between pricing and marketing and new product launch decisions.

441. Brand Management  
Prerequisite: MKT 412 (may be taken concurrently)

This course is the capstone course of the Brand Management Track. Lectures focus on scanner data analysis, and guest speakers discuss timely brand management topics. The main focus is a team project performed for a major consumer packaged goods firm, requiring the analysis of various current data sources, most notably scanner data. The major deliverable is a presentation to the client by each team of their findings. Typically, this amounts to performing a brand review.

442. Special Topics in Marketing  
Prerequisite: permission of the instructor

Special topics are generally those which are not well covered in other other courses, or they may deal with marketing in selected industries (e.g., financial services, high-tech marketing, etc.). The specific content of the course varies, depending on faculty interests.

444. B2B Marketing  
Prerequisites: Dependent upon instructor

This course involves all of the basic marketing functions but it takes on a totally different complexion in that it involves organizations (profit and not profit) that acquire goods and services that are utilized in the production of others goods and services or are used in the overall operation of the organization. Besides the major commercial organizations that make up a sizeable percentage of B2B companies, there are institutional organizations in the mix as well – hospitals, colleges, universities and government. B2B marketing involves several distinct characteristics such as: larger, fewer purchases, centralized buying decisions, multiple buying influences, close supplier/customer relationships etc. The overall market tends to be global in nature and technology is a major influence.

448. Brand Strategy  
Prerequisite: MKT 402

In this project-based course, students consult with the senior leadership teams of local companies that are in need of a brand strategy. In doing so, students address the following questions:

- What is the firm’s desired brand strategy?
- How does the firm currently see its brand?
- How does the marketplace perceive the firm? (Internal and external perceptions rarely match.)
- What can the firm do organizationally (hiring, structure, incentives, etc.) to move toward providing the desired brand?
• What can the firm do using marketing activities, including product and service experiences, to move consumer perceptions toward this desired positioning?

The course introduces students to an intuitive framework in which to develop answers to these questions and a series of research tools to collect the needed information. Students then actually use these tools to help a local company design brand strategy.

Students in this course realize several meaningful benefits:
• Greater preparedness to add immediate value in the corporate workforce, where they are sure to come across the topic of brand building. This class provides them with practical exposure to a proven methodology and an array of appropriate tools for aligning organizations going through a brand transformation or engaging in a brand-related project.
• Access to senior level leadership challenges. This course provides an opportunity for students to interact regularly with the upper management of the participating company, thereby enabling them to learn from real-life, demanding experiences.

Class sessions consist of lectures relating to brand strategy development methodologies and tools and discussions pertaining to the course project. Multiple team meetings with the client firm outside of the scheduled class times are required. Grading is based on peer, professor and client evaluations of team success.

449. Global Marketing Strategy
Prerequisite: MKT 402

This course will develop the concepts of marketing strategy in the context of the resource-based view of the firm and the market focus view of the firm. Marketing strategy formulation and implementation will be related to strategies at the corporate and business unit level as well as other functional areas of the organization. The analytical tools and concepts for strategic analysis will be developed from basic economic principles. Core MBA subject matter will be integrated in the course as a part of the analysis and construction of a marketing strategy. The course examines the importance of bilateral information flows between the firm and the marketplace in defining new product requirements, changing competitive conditions, product advertising, and strategic commitment. The definition of new core capabilities and the use of existing unique resources in creating competitive advantage will be explored. Special emphasis will be given to the impact of globalization and technology on the formulation and implementation of marketing strategy.

451. Advanced Marketing Analytics

This course is designed to give students the knowledge, vocabulary, and confidence to implement customized data analysis, using flexible and adaptable approaches. The course will cover the use of state-of-the-art computational data analysis techniques that are now possible with the widespread adoption of modern computing, including maximum likelihood estimation, and fitting models with custom metrics, optimization, bootstrapping, time series data, binary data, and discrete choice data. Expanding on the topics covered in MKT 436, the course will explore questions such as: How do you customize your analysis approach to new problems? When should you or should you not use regression? How do you integrate the next big thing in data analysis? The course will also discuss potential computational bottlenecks, and the techniques, software, and hardware to avoid them. Students’ basic R programming skills will be expanded. All instruction is “hands on” and students should expect to be proficient in R by the end of the course. This course has been designed for students who have completed an introductory statistics course and who have also either taken MKT 436 or have a basic working knowledge of R.

465A/B. Marketing Projects I & II

This course serves as a practical capstone experience for the MS Marketing Analytics program. Partnering with corporate sponsors, student teams put their training to use in database projects which address practical marketing issues. Corporate guest speakers and practicing analysts guide students in their project work. Strong emphasis is placed on the “context” for applied analytics: the competitive market environment of the firm, customer attributes and sensitivities, marketing program recommendations and optimum business decision-making.

501. Workshop in Marketing
Non-credit
Prerequisite: permission of the instructor

This workshop provides a forum for the presentation of ongoing and completed research by students, faculty and visiting scholars. PhD students are expected to participate actively.

505. Marketing Research PhD Workshop
Prerequisite: permission of the instructor

This workshop provides a forum for the presentation of research ideas and completed research by students. The course includes discussion of current job market papers and AMA interviews, journal reviewing, and generating new research ideas. In addition, some topics are covered to illustrate current research areas of interest for the faculty. All marketing PhD students who are not on the job market are expected to participate actively.

511. Advanced Topics in Marketing I
Prerequisite: permission of the instructor

This course is the first leg of a three-part sequence that prepares PhD students for research in marketing. The presentation of topics between the three parts may vary from year to year. The aim is to survey the literature, assess progress and identify opportunities for future research.
512. Advanced Topics in Marketing II  
*Prerequisite: permission of the instructor*

In this second part of a three-part sequence that prepares PhD students for research in marketing, topics are discussed in a format similar to MKT 511.

513. Advanced Topics in Marketing III  
*Prerequisite: permission of the instructor*

In this third part of a three-part sequence that prepares PhD students for research in marketing, topics are discussed in a format similar to MKT 511 and MKT 512.

**OPERATIONS MANAGEMENT**

402. Operations Management  
*Prerequisites: CIS 401, GBA 411, and GBA 412 or GBA 462*

Operations Management introduces the concepts and skills needed to design, manage, and improve service and manufacturing operations. The course develops a managerial perspective of the operations function and an appreciation of the role that operations plays in creating and maintaining a firm's competitive edge. The course introduces process analysis, performance measurement systems for operations, and production control systems. Quantitative models and case studies apply these skills to service process management, manufacturing, inventory control, supply chain management and project management. The course highlights the role of effective operations management in the strategic direction of the firm as well as the connections between operations and other functional areas.

411. Supply Chain Analytics  
*Prerequisite: OMG 402*

This course gives an overview of supply chain management in a wide variety of industries such as: groceries, style goods, consumer electronics and services. The impact of shifts from traditional channels to e-commerce will be emphasized. New initiatives introduced to address these new challenges, such as vendor managed inventory (VMI), variety postponement, cross docking, real options contracts and quick response, will be studied and applied both in class and assignments. Supporting software, such as Enterprise Resource Planning (ERP) and supply chain tools, will also be discussed.

412. Service Management  
*Prerequisite: OMG 402*

Success of service management critically depends on managing the integration of business processes with customers as well as all related support systems (technology, human resources, information flow). This integration presents a challenge to service managers who need to address significant variation in customer expectations and requirements while controlling costs and remaining competitive. This course provides a foundation for the analysis and improvement of businesses, paying particular attention to the service sector. The type of analysis learned in this course is required in virtually every industry as companies work to improve their bottom-line performance. The best way to improve performance is through a holistic approach, where the structure of processes, information and technological requirements, and the managerial implications, are considered concurrently.

413. Operations Strategy  
*Prerequisite: OMG 402*

For many firms, the operations function marshals the majority share of a firm's assets and resources while producing products and services. Decision-making in operations can have a decisive effect on both the cost and the attractiveness of the firm's outputs. Thus the management of operations activities is a critical factor in a firm's competitive strategy. This is a course that explores operations related decisions in the context of overall business, operations, financial and marketing strategies. Strong emphasis is given to valuation of different operational strategies and NPV analysis. Many types of operations decisions are considered: location, capacity, sourcing, flexibility, and process choice. Risk management and financial evaluation of capital projects will be discussed. In addition to financial evaluation, students will analyze the fit of strategic choices in the competitive context a firm faces.

415. Process Improvement  
*Prerequisite: OMG 402*

This course will teach a systematic method for understanding and improving ongoing business processes. The techniques learned in this class provide a systematic method of asking questions, collecting data, and analyzing that data to learn how processes work (or are failing) and what can be changed to improve them. The statistical techniques you will learn are SPC (Statistical Process Control, used as a proactive tool for investigation rather than its traditional role as a reactive tool), MSA (Measurement Systems Analysis, for determining if your measurement system is capable), FMEA (Failure Modes and Effects Analysis), and DOE (Design of Experiments). In addition to these analysis tools, there will be a strong emphasis on the process of data acquisition. To support the process of acquiring the right data and learning the analysis tools, you will do a small outside project for the class and a series of in-class simulations. You will learn to use two additional tools that support the questioning that leads to good data acquisition: process mapping (of the process you will be improving) and thought process mapping (of the process you use to solve the client's problem).

416. Project Management  
*Prerequisite: OMG 402*

The topics treated in this course span a wide spectrum of issues, concepts, systems, and techniques for managing projects effectively in today's complex business environment. Students are led through a complete project life cycle, from requirements analysis and project definition to start-up, reviews, and phaseout. Important techniques for controlling project costs, schedules, and performance are studied. The course employs a combination of lectures, case analyses, business/project simulations, videos,
Internet resources, and group discussions to develop the conceptual understanding and operational skills needed for effective managerial role performance.

437. Managing Health Care Operations  
(Same as HSM 437)

The health care industry is undergoing rapid growth as well as rapid structural changes. New technology, changing reimbursement mechanisms, and increased competition create many interesting management problems, not in the least in the area of health care operations. In this course, we will study the operations of various types of health care provider organizations (such as hospitals, HMO's, group practices, nursing homes, etc.) and other participants in the industry (such as insurance companies, pharmaceutical companies, suppliers and consulting companies). Topics that will be studied include: patient and provider scheduling, capacity management, providing services and supplies to health care providers, new product development and integrated delivery systems. Students who took OMG 402 need to obtain instructor’s permission prior to registration.

460. Special Topics in Operations Management  
Prerequisite: OMG 402

This course provides a critical study of selected topics in operations management focusing on best practice and the status of research efforts to date. Potential topics are: yield management, operations and information management issues in retail fashion and media, transportation management, or customers’ relationship management.

461. Strategy and Business Systems Consulting Practicum  
(Same as CIS 461 and STR 461)

This course provides students with an introduction to strategy and business systems consulting. It is aimed at students who wish to explore career opportunities within the major consulting firms, but is also relevant for students considering a career as an independent consultant, or within a corporation’s internal consulting group. The course focuses on three areas:

- The Consulting Industry: Students will examine several types of consulting (e.g., strategic, operations, systems, human resource, and marketing) and understand where the major consulting firms position themselves. The career paths for graduates entering the industry, and the skills and values necessary for success as a consultant will be scrutinized.

- The Business Systems Consulting Process: The creation of proposals, the winning of consulting engagements, and the preparation of contracts will be discussed. The typical stages of a business systems consulting engagement (e.g., problem framing, analysis design, gathering data, interpreting results, architectural solution, and presentation of recommendations) and managing different sorts of consulting projects (e.g., operational improvement, supply-chain optimization, quality improvement, strategy formulation, and organizational design) will be examined.

- Consulting Skills: The role of the consultant and the human dimension will be discussed (e.g., personal attributes of consultants, relationship building, and team building). Diagnostic tools and data gathering techniques (e.g., questionnaires and interviews) will be presented. Frameworks for problem solving, and communicating recommendations will also be introduced.

The course examines a wide range of modern global business challenges and opportunities from both the consultant’s and the manager’s perspectives and provides a learning platform to integrate and practice the skills and knowledge learned.

501, 502, 503, 521, 522, 523. PhD Seminars in Operations Management

These six PhD seminars are offered in the fall, winter and spring quarters, with major topics such as the following: distribution/inventory theory; flexible-manufacturing systems; (production) batching, scheduling and sequencing; reliability/maintenance management; design/strategy; routing/vehicle scheduling; quality; production-control systems; and planning models. Topics for the joint CIS/OMG seminars include: computer-integrated manufacturing, network-based industries, performance evaluation of dynamic systems, business expert systems and artificial intelligence.

531. Analysis of Production Systems

The course introduces the theory of production and inventory systems, and discusses mathematical models used in designing and managing real-world systems. Topics include: aggregate production planning, static and dynamic approaches to operations scheduling, inventory control with known and uncertain demand, flexible and high-volume manufacturing systems, hierarchical production planning systems and manufacturing resource planning.
Margaret Warner Graduate School of Education and Human Development

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General Information

The Margaret Warner Graduate School of Education and Human Development offers programs leading to the Doctor of Philosophy (PhD), Doctor of Education (EdD), Master of Science (MS), and Master of Arts in Teaching (MAT) degrees, as well as a several non-degree programs leading to professional certifications.

For all graduate programs, admission to the Warner School is made through the Admission and Financial Aid Committee. Admission decisions for master’s and EdD applicants are made at specific times during four application cycles, with deadlines in October, January, March, and June; PhD applications are reviewed in the January cycle only.

Admission to all programs is based on the applicant’s record of academic achievement, letters of recommendation, writing sample, personal interviews when required, and the fit of research and career goals and professional interests with the Warner School’s research programs and resources. Transcripts of higher education coursework, both graduate and undergraduate, should be forwarded directly from all institutions attended.

In 2015, the New York State Legislature approved a law that stipulates applicants to teacher preparation programs that lead to initial teacher certification or educational leadership programs that lead to the school building leadership (SBL) or school district leadership (SDL) certification must submit official scores of a graduate school entrance examination. To be in compliance with this New York State regulation, the Warner School requires official results of the Graduate Record Examination (GRE) or Miller Analogies Test (MAT). The Warner School is now an official testing center for the MAT, providing students and the surrounding community a place to take the nationally standardized exam in Rochester. The Test of English as a Foreign Language (TOEFL) or the academic module of the International English Language Testing System (IELTS) is required for applicants who are nonnative English speakers. In some cases, this requirement is waived for international students who can otherwise demonstrate English proficiency.

Applicants who wish to be considered for financial aid in the form of an assistantship and/or scholarship should indicate that in their application. Additional information about applications and financial aid can be obtained from the Admissions Office, (585) 275-3950 or admissions@warner.rochester.edu. All program requirements and course descriptions in this bulletin are subject to change. For the most up-to-date program requirements and course descriptions, please visit us on the web at www.warner.rochester.edu.

Doctoral Programs

The Warner School offers two types of doctoral programs: Doctor of Philosophy (PhD) and Doctor of Education (EdD). The PhD program is designed specifically to prepare students for careers devoted to research and scholarship, particularly in a university environment. The EdD is designed to enable outstanding professionals to apply research to their field of practice.

Both degree programs require 90 credit hours (96 for students specializing in counseling). Students who have already undertaken relevant graduate-level coursework may be allowed to transfer it to their program (up to a limit of 30 credits for PhD students and 36 credits for EdD students) provided that: (1) the course(s) in question was taken within 10 years of the date of matriculation; (2) a grade of “B” or higher was earned; (3) they are approved by the student’s advisor, program chair, and associate dean of graduate studies. If the courses were completed more than 10 years ago, students are required to submit a curriculum vitae and written narrative, describing how they have remained involved in their field of study, to help the advisor, chair, and associate dean to determine whether exceptions could be made. Transfer credit decisions are made at the time of approving each student’s program of study. Courses taken at institutions other than the University of Rochester after matriculation into the doctoral program may not be used toward the doctoral degree.

In addition to coursework, doctoral students also need to successfully complete a set of milestone experiences. First, after having completed at least 18 credits in the program, all doctoral students must submit a portfolio for review. The portfolio review is evaluative, with feedback offered by faculty that is intended to nurture developing research expertise and intellectual and professional development. After passing the portfolio assessment and having completed most of the coursework for the degree, all doctoral students undertake an individualized comprehensive examination. Specific requirements for the comprehensive exam vary by program area. Finally, all doctoral programs culminate in the completion of a doctoral dissertation.

Advancement to candidacy for the PhD or EdD degree occurs upon successful defense of the dissertation proposal. The degree is awarded after completion of all degree requirements, and upon successful oral defense and acceptance of the doctoral dissertation.

All work for the doctoral degree, including the final oral examination on the dissertation, must be completed within seven years from the date of initial registration. Students with 30–36 credit hours accepted in the doctoral program must complete all work within six years from the date of matriculation in the doctoral program. Students who for good reason have been unable to complete a program within the above stated limits may, upon recommendation by the faculty advisor and the program chair, petition the associate dean of graduate studies for an extension of time. Such extension, if granted, will be of limited duration, must be re-approved at least biannually, and it may require additional coursework.

Students must maintain continuous registration through the program. Full-time students must register for at least 12 credit hours, or nine credit hours with an assistantship, during
Master’s Programs

The Warner School is committed to excellence in pre-service and in-service preparation of education professionals at the master’s level. It maintains programs that prepare students to undertake a wide variety of professional roles in schools and other educational settings. Several of these programs also enable students to satisfy all the academic requirements needed to obtain initial and/or professional certification from New York State or become eligible for licensure. All these programs combine strong emphasis on professional excellence with the University’s commitment to sound scholarship and are nationally accredited by NCATE (now consolidated into CAEP) and/or CACREP.

All master’s degrees require completion of at least 30 credit hours of coursework, although many MS degree programs require additional credit hours (as indicated for each program listed in this section).

Transfer credit pertains to graduate coursework from another institution or another school or college within the University of Rochester that is completed before the student matriculates into a degree program at the Warner School. Retroactive credit pertains to coursework completed at the Warner School prior to matriculation into a degree program. No more than 10 credit hours may be accepted as transfer credit into a master’s degree. It is possible that a combination of transfer and retroactive credit may exceed 10 credit hours. Transfer credit and retroactive credit are permitted only when they meet the following criteria: (1) must have been taken within five years of the date of matriculation, (2) must have received a grade of B or higher, and (3) must meet the approval of the faculty advisor, program chair, and the associate dean of graduate studies. Courses taken at institutions other than the University of Rochester after matriculation in the master’s degree program may not be used toward the master’s degree.

The total time limit for completing a master’s degree is five years. Requests for extension of this deadline must be submitted in writing to the associate dean of graduate studies. Such extensions, if granted, will be of limited duration and may require additional coursework.

Students may pursue the MS degree on a full-time or part-time basis. In cases that require a field placement (student teaching, practicum, or internship), however, it may be necessary to spend one or two semesters in full-time residence. Policies regarding conditions for fulfillment of field placement responsibilities vary from program to program. All master’s programs require a culminating assessment, although the nature of this assessment varies across programs (master’s essay, thesis, portfolio, or comprehensive exam). Students must maintain continuous registration throughout the program. Continuous registration for part-time students means registration for a total of nine credit hours every academic year sequence of summer-fall-spring semesters until the degree program is completed. If a student does not register for coursework during any fall or spring semester, that student must register for continuation of enrollment for that semester. Students have to either register for courses or for continuation of enrollment every fall and spring semester until the program degree is completed.

PhD in Education

The Warner School offers several areas of study within the PhD in Education. Students may concentrate in one of the following areas: Counseling and Counselor Education; Educational Policy and Theory; Higher Education; Human Development; and Teaching, Curriculum, and Change. PhD dissertations should provide an original and scholarly contribution to research in the student’s major field. A minimum of one year of full-time residency is required of all PhD students.

Doctor of Education Degrees

The Warner School offers four EdD programs with additional concentrations in the following areas: K–12 Educational Administration; Higher Education; Teaching and Curriculum; Mental Health Counseling and Supervision; Counseling; and Human Development. There is no minimum residency requirement for this program, although students are strongly encouraged to make arrangements so that they can devote the necessary time to their dissertation.

Students completing the EdD in Mental Health Counseling and Supervision are automatically eligible for the New York State mental health counseling license. Students graduating from this program would be eligible for a New York State limited permit and would need to complete 3,000 postgraduation supervised practice hours and pass the state examination to become a fully Licensed Mental Health Counselor (LMHC).

The Warner School offers an accelerated option for EdD students who are experienced practitioners in their field of specialization and want to pursue the degree part time while holding a professional job in the same field, with a specially structured and supported yearlong dissertation cohort process. This option makes it possible for eligible students to earn a doctorate in education in as few as three years on a part-time basis for most EdD programs. Additional admission criteria and program requirements must be met by students choosing the accelerated option.

Master’s Programs

The Warner School is committed to excellence in pre-service and in-service preparation of education professionals at the master’s level. It maintains programs that prepare students to undertake a wide variety of professional roles in schools and other educational settings. Several of these programs also enable students to satisfy all the academic requirements needed to obtain initial and/or professional certification from New York State or become eligible for licensure. All these programs combine strong emphasis on professional excellence with the University’s commitment to sound scholarship and are nationally accredited by NCATE (now consolidated into CAEP) and/or CACREP.

All master’s degrees require completion of at least 30 credit hours of coursework, although many MS degree programs require additional credit hours (as indicated for each program listed in this section).

Transfer credit pertains to graduate coursework from another institution or another school or college within the University of Rochester that is completed before the student matriculates into a degree program at the Warner School. Retroactive credit pertains to coursework completed at the Warner School prior to matriculation into a degree program. No more than 10 credit hours may be accepted as transfer credit into a master’s degree. It is possible that a combination of transfer and retroactive credit may exceed 10 credit hours. Transfer credit and retroactive credit are permitted only when they meet the following criteria: (1) must have been taken within five years of the date of matriculation, (2) must have received a grade of B or higher, and (3) must meet the approval of the faculty advisor, program chair, and the associate dean of graduate studies. Courses taken at institutions other than the University of Rochester after matriculation in the master’s degree program may not be used toward the master’s degree.

The total time limit for completing a master’s degree is five years. Requests for extension of this deadline must be submitted in writing to the associate dean of graduate studies. Such extensions, if granted, will be of limited duration and may require additional coursework.

Students may pursue the MS degree on a full-time or part-time basis. In cases that require a field placement (student teaching, practicum, or internship), however, it may be necessary to spend one or two semesters in full-time residence. Policies regarding conditions for fulfillment of field placement responsibilities vary from program to program. All master’s programs require a culminating assessment, although the nature of this assessment varies across programs (master’s essay, thesis, portfolio, or comprehensive exam). Students must maintain continuous registration throughout the program. Continuous registration for part-time students means registration for a total of nine credit hours every academic year sequence of summer-fall-spring semesters until the degree program is completed. If a student does not register for coursework during any fall or spring semester, that student must register for continuation of enrollment for that fall or spring semester. Students have to either register for courses or for continuation of enrollment every fall and spring semester until the degree program is completed.
Prospective applicants are encouraged to visit us on the web and contact the Warner School's Admissions Office for specific details about requirements. The most up-to-date program requirements and course descriptions are available at www.warner.rochester.edu.

Programs Preparing Entry-Level Teachers
The Warner School offers a variety of master’s programs and options that lead to New York State Initial Teaching Certification in specific subject matters and/or grade levels. These programs also satisfy all the academic requirements for professional teaching certifications in the same area and are nationally accredited (CAEP/NCATE).

Master’s degrees, leading to NYS teaching certification in one of the following areas:

- Early Childhood (birth to grade 2) 45 credits
- Elementary/Childhood (grades 1–6) 45 credits
- Middle Childhood* (grades 5–9) 39 credits
- Adolescence* (grades 7–12) 39 credits
- Middle Childhood and Adolescence* (grades 5–12) 42 credits
- TESOL/Teaching English to Students of Other Languages (grades K–12) 39 credits
- Inclusive/Special Education (birth to grade 2, grades 1–6, and grades 7–12 as generalist) 45 credits
  (Students can do dual certification in inclusion and early childhood or childhood education or additional coursework to obtain NYS annotation for Teaching Students with Severe and/or Multiple Disabilities.)

MAT in (Subject Area)*, leading to NYS teaching certification in Adolescence (grades 7–12) 51 credits

Additional Teaching Certifications
Students who meet the prerequisites and are interested in dual certification in one of the above areas and Teaching Students with Disabilities can do so by adding an additional 12 credit hours of required courses in inclusion/disabilities to any of the previous programs and conducting their internships in inclusive settings. Students interested in additional specializations can also pursue Advanced Certificates in Urban Teaching and Leadership Program and Digitally Rich Teaching in K–12 Schools.

Programs for Current Teachers
The Warner School offers a variety of options to initially certified teachers interested in pursuing professional certification through a master’s degree and/or seeking an additional certification.

Master’s degrees (same area of specialization) 30 credits

Master’s degrees (leading to NYS certification at a new grade level or in a different specialization) 35 credits

MAT in (Subject Area of Specialization) 30 credits

Master’s in Inclusive/Special Education (also satisfying all requirements for NYS certification in Teaching Students with Disabilities in the same area of specialization) 30–35 credits

Master’s degrees in Reading and Literacies (also satisfying all requirements for NYS certification in Teaching Literacy) 36 credits

Programs Preparing for Entry-Level Positions in Counseling
There are a few different master’s programs available for counselor preparation leading to the following specializations:

- School Counseling, leading to NYS Provisional Certification in School Counseling: 48 credits
- School Counseling, leading to NYS Provisional Certification in School Counseling and the required coursework to later attain NYS Professional (Permanent) Certification (with concentrations in School and Community, Disability, Diversity, or Leadership): 60 credits
- Mental Health Counseling, leading to NYS licensure eligibility in mental health counseling—a licensure exam and 3,000 hours of postgraduate supervised experience are also required for licensure: 60 credits

Programs Preparing Entry-Level K–12 School Administrators
Experienced teachers or counselors interested in assuming administrative positions in New York State are required to obtain a School Building Leadership (SBL) certification for positions at the building level, or School District Leadership (SDL) certification for positions at the district level. The following degree programs have been designed to fulfill all coursework and internship requirements for each or both of these certifications.

- MS in Educational Administration, leading to SBL certification: 36 credits
- MS in Educational Administration, leading to SDL certification: 36 credits (an additional 24 graduate credits are required to meet New York State’s 60 graduate credit requirement for certification)

- MS in Educational Administration, leading to SDL certification with additional certification as SBL: 36 credits (an additional 24 graduate credits are required to meet New York State’s 60 graduate credit requirement for certification)

Students interested in specializing in Catholic, private, and/or independent schools can pursue additional seminars and experiences to prepare for these contexts.

Master’s Programs without Certification
The Warner School also offers a number of master’s degrees for students interested in obtaining an introduction to various fields of education, either to increase their qualifications for professions that do not require a specific certification, or to prepare to enter a doctoral degree program.

* These programs lead to NYS Teaching Certification in one or more of the following subjects: English, foreign languages (French, Spanish, German, Italian, and/or Chinese), Latin, mathematics, science (biology, chemistry, physics, and/or earth science), and social studies.
MS in Human Development (with specializations in Early Childhood, Family Studies, Developmental Differences, Gerontology, Program Evaluation, or Research) 30 credits

MS in Teaching and Curriculum (general) 30 credits

Master’s degree (with specializations in Early Childhood, Elementary, Inclusion/Special Education, Literacy, Mathematics, Science, or Social Studies) 30 credits

Master’s degree in Teaching English to Speakers of Other Languages (outside U.S. K–12 schools) 30 credits

MS in Educational Administration (with concentrations in K–12 School Administration, Higher Education Administration, Higher Education Student Affairs Administration, or Higher Education Student Affairs and Academic & Career Advising) 36 credits

MS in Education Policy 30 credits

MS in Program Evaluation 33 credits

MS in Online Teaching and Learning 33 credits

MS in Health Professions Education 30 credits

MS in Applied Behavior Analysis 39 credits

Non-Degree Programs

Students who already hold a master’s degree but are seeking additional NYS certifications can also pursue their goals by enrolling in one of the Warner School’s non-degree programs leading to a specific certification (registered with the NYS Education Department). The number of credit hours necessary to complete each of these certification programs depends on each student’s previous background.

Non-Degree Programs, Leading to Additional Teaching Certification in the Following Areas

Early Childhood (birth to grade 2)
Childhood (grades 1–6)
Middle Childhood* (grades 5–9)
Adolescence* (grades 7–12)
Teaching Students with Disabilities (at one of the three grade levels: birth to grade 2, grades 1–6, or grades 7–12)
Teaching Students with Severe and/or Multiple Disabilities (NYS Annotation)
Reading and Literacies (birth to grade 6 or grades 5–12)
Teaching English to Students of Other Languages (grades K–12)

Non-Degree Programs Leading to Administrative Certification in the Following Areas

School Building Leadership (24 credits)
School District Leadership (24 credits—assuming that additional 36 graduate credits have been previously completed to meet New York State’s 60 graduate credit requirement for certification)
School Building and School District Leadership (27 credits—assuming that additional 33 graduate credits have been previously completed to meet New York State’s 60 graduate credit requirement for certification)

School Building Leadership (24 credits—with specialization in Catholic and other private schools)

Non-Degree Programs Leading to NYS Professional (Permanent) Certification in School Counseling

(12 additional credits)

Non-Degree Programs Leading to NYS Approved Advanced Certificates

The Warner School also offers the following non-degree programs consisting of a series of courses and internships:

Advanced Certificate in Urban Teaching and Leadership (9 credits), a sequence including two courses and three one-credit seminars for teachers interested in urban settings

Advanced Certificate in Teaching English as a Foreign Language (13–15 credits), a post-baccalaureate certificate without U.S. teacher certification for individuals interested in teaching English abroad

Advanced Certificate in Program Evaluation (15 credits), can be pursued as a stand-alone program OR concurrently with another Warner program

Advanced Certificate in Online Teaching (15 credits, of which three are field experiences), can be pursued as a stand-alone program OR concurrently with another Warner program

Advanced Certificate in Digitally Rich Teaching in K–12 Schools (12 credits or less), can be pursued as a stand-alone program OR concurrently with another Warner program

Advanced Certificate in Applied Behavior Analysis (33 credits), for individuals who already have a master’s degree in an approved area; may allow for some transfer credits from previous and/or concurrent graduate programs

Interdisciplinary Programs

Health Professions Education

The master’s in health professions education, a 30-credit program offered by a collaboration of the University of Rochester Schools of Education, Nursing, and Medicine and Dentistry, is designed for health care professionals—nurses, doctors, physical therapists, dentists, chiropractors, physician assistants, pharmacists, nutritionists, and other health care specialists—who are in health care education and those who are interested in moving

* These programs lead to NYS Teaching Certification in one or more of the following subjects: English, foreign languages (French, Spanish, German, Italian, and/or Mandarin Chinese), Latin, mathematics, science (biology, chemistry, physics, and/or earth science), and social studies.
into such positions and who seek formal training in education. The interdisciplinary program provides theoretical and practical preparation for teaching and related skills to health care professions.

Additional Programs

Higher Education
The Warner School’s master’s programs in higher education prepare thoughtful practitioners for positions at postsecondary institutions, in government, and in many organizations that work with and for colleges and universities. The master’s with a concentration in student affairs administration offers students an opportunity to combine practical leadership experience in student affairs with a dynamic academic program. The master’s with a concentration in general higher education administration provides this same energy with a focus on administration and governance. The master’s with a concentration in student affairs and academic and career advising is centered on the administration of student affairs and student development from the higher education program and academic and career advising from the counseling and human development program. At the doctoral level, the Doctor of Education (EdD) in educational administration is offered with a concentration in higher education and the Doctor of Philosophy (PhD) is offered with a concentration in higher education.

Education Policy
A Master of Science (MS) degree in education policy is offered for those interested in assuming policy positions or planning to pursue doctoral study in areas related to educational policy. The master’s program enables students who want to have a meaningful impact on preschool, K–12, and/or higher education at a systems level and to examine and understand contemporary policy issues impacting the educational spectrum. The 30-credit program makes it possible for candidates to receive their degree in one year (e.g., summer, fall, and spring semesters) of full-time study. Graduates acquire a deep understanding of our education system and education reform nationwide and are prepared to work as policy analysts, educational policymakers, and researchers at government agencies, nonprofit organizations, districts, and higher education institutions. At the doctoral level, the Doctor of Philosophy (PhD) in education is offered with a concentration in educational policy and theory. This program is geared toward students who have an advanced degree in policy, political science, economics, sociology, or a related area and are interested in a career as a higher education faculty member or in an organization conducting policy research and analysis.

Counseling
The Warner School’s master’s programs in counseling provide students with the knowledge and skills to become effective school or community-based mental health counselors who help individuals, families, organizations, and communities make changes that will lead to healthy human development. Students learn how to work one-on-one with individuals and with groups, and they explore the important role that counselors play in advocating for systems in schools and organizations that promote health, development, and well-being. The master’s program in community mental health counseling, which leads to New York State licensure in mental health counseling, takes about two years of postgraduate study. The school counseling program, which leads to New York State certification as a school counselor, also can be completed in about two additional years.

Human Development
The Warner School’s programs in human development contribute to theory, research, and practice concerning human development and the environmental factors shaping the developmental processes that lead to lifelong wellness. Graduates pursue positions in health and human service agencies; research in a variety of development-related areas, including child and adolescent development, family studies, gerontology, and community development and empowerment; and family outreach. Many continue their education in doctoral programs. The master’s program enables students to design a program to meet their interests; a general program in human development or a specialization in early childhood, family studies, developmental differences, gerontology, program evaluation, or research.

Applied Behavior Analysis
The programs in applied behavior analysis (ABA) prepare students for eligibility as a Licensed Behavior Analyst (LBA) in New York State and/or Board Certified Behavior Analyst (BCBA). Graduates are prepared to work with individuals with autism and related disorders in schools, community agencies, and in their homes as part of an interdisciplinary team. The 39-credit master’s program and the 33-credit advanced certificate program meet the coursework and the minimum hours of university-supervised practicum hours required by New York State; however, students need to complete the Child Abuse Prevention Workshop and additional supervised practicum hours in order to sit for the licensing exams.

Online Teaching
The programs in online teaching prepare qualified instructors, instructional leaders, and support staff to leverage online learning and digital devices to improve student learning in a variety of contexts. The master’s in online teaching and learning is a 33-credit program that includes all the requirements and learning experiences of the Advanced Certificate in Online Teaching, as well as a research methods course and five electives. The Advanced Certificate in Online Teaching is a 15-credit program that can be completed as a standalone, nondegree program or as an addition/enhancement to other University of Rochester programs.
Program Evaluation

The program evaluation programs offer an opportunity to learn how to collect, analyze, and use information to answer questions about projects, policies, and programs, with particular attention to program implementation, effectiveness, and efficiency in education and other institutional settings. The master's in program evaluation is a 33-credit program that includes a culminating master's capstone project based on an independent program evaluation experience. The certificate in program evaluation is a nondegree post-master's series of courses and internships to prepare program evaluators (may also be earned as an addition/enhancement to other Warner School and University of Rochester programs).

Graduate Courses

ED 400A. Topics in Teaching and Schooling, Part 2
Prerequisites: [ED 400]
Like ED 400, this course addresses a range of topics related to teaching and schooling that the Warner School has identified as important in preparing pre-service teachers to become successful, critically reflective educational professionals. This second semester of Topics is divided into workshop modules, each of which addresses a specific area of concern. Additionally, this course provides unique opportunities for candidates across Warner's initial teacher certification programs to operate as a common intellectual community, and to make valuable connections to local networks of educational professionals and other key stakeholders. (Offered: Spring)

ED 400. Topics in Teaching and Schooling, Part 1
Prerequisites: (Restrictions: Non-matriculated students discouraged from taking this course; select few by permission of instructor)
Addresses a range of topics related to teaching and schooling that the Warner School has identified as important in preparing pre-service teachers to become successful, critically reflective educational professionals. The two-semester course is divided into workshop modules, each of which addresses a specific area of concern. Additionally, this course provides unique opportunities for candidates across Warner's initial teacher certification programs to operate as a common intellectual community, and to make valuable connections to local networks of educational professionals and other key stakeholders. (Offered: Fall)

EDE 401. Introduction to U.S. Education
This is a one-credit course designed for entering international students. This fully online course aims to familiarize new international students with the U.S. educational system and current issues in U.S. educational settings that may be discussed in classes at Warner. This course will include modules about how schooling is structured from K-12 to postsecondary education in the U.S., issues related to diversity and equity (including race, ethnicity, gender, ability, language), new educational mandates such as common core standards and teacher evaluation systems, as well as topics. (Offered: SummerB)

ED 404. Teaching, Curriculum, and Change
Provides a critical understanding of the social, cultural, historical, and political context of contemporary schooling, including the realities of teaching and prevailing images of teachers’ work; student assessment and evaluation; standards and teacher accountability; the social organization of schools; and the influence of popular media, commercialization, and privatization on teaching and learning. (Offered: Fall, Summer B)

EDE 404. Basics in Applied Quantitative Analysis
Prerequisites: [ED 406, or by permission of instructor] (Restrictions: Master’s students only)
Introduces master’s students to quantitative data analysis. Prepares students to use the PASW/SPSS statistical software program and conduct basic descriptive and inferential statistical analyses. Students learn how to apply statistical techniques to address research questions using real datasets and how to interpret and present findings. (Offered: Occasionally)

ED 405. Assessment in Instructional Contexts
Develops a comprehensive understanding of the multiple purposes of assessment. Provides a critical overview of the historical foundations of educational assessment and consequences of assessment and testing. Helps course participants to understand assessment as an ongoing part of instruction and reflective practice and to develop the ability to use assessment to guide instruction and improve student achievement. Familiarizes students with processes, procedures, and laws surrounding the use of assessment, particularly in special education, and provides opportunities to learn how to effectively and critically use a variety of tools and procedures in the determination of students’ eligibility for educational services as well as the role that assessment plays in the diagnosis and construction of ability and disability. (Offered: Fall, Summer A)

ED 406. Master’s Research Methods
Introduces research methods and research design in education, emphasizing both qualitative and quantitative research design and analytic thinking. Prepares students to be literate consumers of education and counseling research using multiple methodologies. (Offered: Fall, Spring, Summer A, Summer A&B, Summer B)

ED 407. Development, Learning, and Teaching for Children Ages 3 to 5
Prerequisites: (Restrictions: Open to matriculated students only; pre-service teachers take this course concurrently with student teaching in settings that serve preschool-aged children (e.g., EDF 442 or 443))
Provides an understanding of the developmental accomplishments of children from ages three to five and of the ways this development can be affected by a variety of factors, including individual and environmental variables and instruction. Considers the range of programs designed to serve preschoolers, the regulations that govern these programs, standards for accreditation, and ways to support parents of preschoolers. Examines issues of school readiness and expectation. (Offered: Spring)
EDU 407. Curricular and Instructional Leadership
Provides an in-depth analysis of the processes and leadership practices involved in the creation of a mission driven school; includes the process of meaningfully including multiple stakeholders in the articulation of a school/district mission. Examines the complex, multi-year creation of a coherent curriculum that applies current theory to the practices of designing and assessing educational experiences. (Offered: Fall, Spring)

ED 408. Development, Learning, and Teaching for Children Ages Birth to 3
Prerequisites: (Restrictions: Pre-service teachers take this course concurrently with field experiences in a setting that serves children ages birth to three (e.g., EDF 440 or 441))
Provides an understanding of the development that ordinarily occurs in children from birth to three years old and of the ways this development can be affected by a variety of factors, including individual and environmental variables and instruction. Examines the range of programs designed to serve very young children, the regulations that govern these programs, and the assessment tools commonly used. (Offered: SummerB)

ED 409. Language and Literacy in Education
Prerequisites: [EDU 498 recommended]
Engages students in understanding how language and literacy work broadly in society and specifically in schools and other educational contexts. Introduces students to broad areas of language study (sociolinguistics, globalization and language) while asking fundamental questions about the nature of language and literacy learning. Explores the complexity, diversity, and power of language (written, spoken, and visual) as a tool for communicating and thinking, and how it may affect learning in specific content areas. Provides an opportunity for reflecting upon the implications of language study for teaching and learning in schools in a global economy. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall, Spring)

ED 410. Learning in the Digital Age
Explores changes in learning practices, new learning environments, and the opportunities and dilemmas brought about by new technologies and more ubiquitous Internet connectivity. Examines a variety of topics and perspectives on these issues through a variety of seminar readings and discussions. Engages students in experiences as learners in digital spaces and provides them with the flexibility to tailor course assignments to fit their individual interests and fields or program areas. This hybrid course meets face-to-face for the first and last class sessions, and in online synchronous sessions for the remainder of the semester. (Offered: Spring (odd))

EDU 411. Education Finance Issues in K-12 School Systems
Examines school finance policy issues related to the origination, allocation, and utilization of resources in public K-12 school systems. Addresses resource allocation processes at the state, district, and school levels; alternative methods of financing schools; and the perplexing issues of equity and efficiency. (Offered: Fall (even))

ED 412. Sociology of Education
Uses a sociological lens to examine U.S. schools and schooling, focusing on social inequality. Examines the relationship between education and society by reviewing major theoretical perspectives and both current and historical issues. Topics covered include: educational stratification within and across schools (inequality relating to class, race, and gender), educational attainment, schools as social systems, social capital, and social networks. Considers the role of social forces outside of the educational system and how these influence educational processes; the ways that schools promote equal opportunity or reproduce power, privilege, and hierarchy; and related areas. While the class focuses on education, we do not focus exclusively on the educational system but rather study the interconnection between schooling and other aspects of society such as housing, transportation, and economic development. (Offered: Spring (odd))

ED 413. Student Affairs Administration: Academic Support Services
This course is designed to tie theory to professional practice in student affairs. Provides an introduction and practitioner’s overview of academic support services in American higher education, including history and theories, student experiences, organization and administration, technology, current issues, and future challenges. Guest presentations by practicing professionals complement class offerings. (Offered: Spring (even))

EDE 413. Seminar in Teaching Chinese (0 credits)
Prerequisites: [Concurrent with EDU 435]
Student teaching seminar for students who are NOT doing practice through the Warner School but already teaching. (Offered: Fall, Occasionally)

EDU 413. Contemporary Issues in Education Policy
Prerequisites: (Restrictions: Open to graduate level students or by permission of instructor)
This course introduces students to several currently pressing educational policy issues and debates at the local and state levels. The course is designed to provide content knowledge and encourage critical thinking about the issues/problems being addressed by state and local policies; the nature and effects of these policies; and the complexities of major policy issues. The course focuses on the impact of recent policies on the public school system, the school organization, and educational performance. The course pays particular attention to issues of equity and social justice relating to race and socioeconomic status. (Offered: Fall)
EDU 414. American Educational and Linguistic Practices
Prerequisites: (Restrictions: For international students who use English as an additional language and have not previously studied in the U.S. their first language)

Designed to lend support to incoming international students who are making the transition to studying in an American university, this course explores the academic culture, language, and customs of U.S. higher educational institutions. Written and oral communication practices in classroom discourse are covered, enabling students to interact effectively with professors and other students in a university classroom. Discusses university expectations for academic reading and writing, including the appropriate use of sources (avoiding plagiarism) and provides instruction in effective strategies and practices to meet those expectations. (Offered: Fall, Spring)

ED 415. Adolescent Development and Youth Culture (ages 10 to 20)

Develops an understanding of what it means to be an adolescent in present day American culture. Explores adolescent development as an integral part of life-span development, employing cultural, psychological, social, and biological perspectives. Examines popular culture, the commodification of youth culture, and media practices that shape and influence adolescent development. (Offered: Fall, SummerA)

EDU 416. Understanding and Managing Conflict in Professional Organizations

Looks at why conflict arises in professional relationships and organizations, and offers both a conceptual framework and a set of tools for understanding and navigating it. Conflict is viewed as not only an inescapable aspect of life, but as a necessary ingredient for highest quality decisions, universally embraced strategies, and strongest working relationships. Conflict tools for capitalizing on these possibilities are practiced in a workshop format, applied to interpersonal, teamwork, mediation, and negotiation problems. (Offered: Occasionally)

EDE 417. Crisis Counseling and Disaster Mental Health
Prerequisites: [EDU 450 or EDU 472] (Restrictions: Restricted to counseling students or other mental health professionals (with permission of instructor))

Examines the crisis counseling and disaster mental health field with an emphasis on improving the well-being (mental health) of those who are survivors or extended survivors of a crisis event or disaster. The objective of the course is to address the psychological reactions and human response to crisis and the appropriate responses of mental health professionals to these events. Topics covered include: crisis and disaster management; disaster theory and models; and post-trauma interventions such as psychological first aid, psychological triage, and emergency trauma treatment protocols. Addresses the assessment, diagnosis, and treatment of crisis/disaster-related issues, such as stress, acute stress disorder, acute crisis episodes, trauma, and PTSD. Investigates current evidence-based practice and research in crisis/disaster mental health, and addresses the role of the counseling professional in the development, training, and care of an effective crisis team and the development of community resources. (Offered: Fall, Spring)

ED 418. The Family and Social Dynamics

Explores the cultural, social, and political structures that shape, change, and maintain “family,” addressing questions central to the study of family and families: What do we mean when we say family? Why is kinship always the center of human society? What are the roles of family policies in shaping family practices? To address these questions, we draw on personal histories, different theoretical perspectives, empirical research, current events, and public policy issues. Examines proximal processes and strategies of “doing family” and the distal arrangements and multiple contexts shaping these practices, bringing attention to how the family interacts with educational, governmental, community, faith-based, and other organizational groups constructed to “support” families. Explores research methodologies and methods emerging from different theories and their strengths and limitations, and studies family issues and policies, examining how they take shape, and how they shape families. (Offered: Spring)

ED 419. Life Course Studies
Prerequisites: [ED406 recommended]

A critical survey of existing scholarly knowledge, research, and theory about the development across the life course, from childhood to late life. Examines how socio-historical forces, timing of transitions, societal institutions, heterogeneity or variability, social ties, human agency, and interpersonal expectations shape the individual’s biographical experience and view of his or her personal past and future. Implications for practice and research are discussed. (Offered: Fall, SummerB)

EDU 421. Human Resource Management

Provides an introduction to, and an overview of, human resource management in educational organizations. Emphasizes issues related to working with people in organizations, collective bargaining, contract administration, evaluation and supervision, and strategic planning. (Offered: Fall)

EDE 422. Motivation in Human Development

Provides a survey of theory and research in human motivation, with particular application to human development, educational and organizational settings, and counseling. Explores several influential approaches to motivation before focusing on one major contemporary approach known as self-determination theory. Topics covered include: the distinction between intrinsic and extrinsic motivation; processes of socialization and internalization; and the importance of basic psychological need satisfaction in educational, organizational, and counseling contexts. Emphasis is placed on application of motivational principles in the professional settings identified above. (Offered: Fall, Spring)
EDU 428. Theory and Practice in Teaching and Learning Social Studies in Elementary School

Prerequisites: (Restrictions: Pre-service teachers must take this course concurrently with their spring student teaching experience (e.g., EDF 408 or 409))

Prepares teachers to facilitate the learning of history and other social sciences for all students in elementary school. Examines the key questions of what should be taught, why and how in the elementary school social studies curriculum, in light of relevant research on the learning and teaching of social studies, state and national standards, and promising practices. Introduces and examines strategies to differentiate instruction so as to meet the needs of diverse students with a range of learning styles and abilities. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)

EDU 429. Theory and Practice in Teaching and Learning Science in Elementary School

Prerequisites: (Restrictions: Pre-service teachers should take this course concurrently with their fall student teaching experience (e.g., EDF 406 or 407))

Prepares teachers to make the learning of science more meaningful and accessible to all students in elementary school. Examines the key questions of what should be taught, why and how in the elementary school science curriculum, in light of relevant research on the learning and teaching of science, state and national standards, and promising practices. Identifies and analyzes exemplary curricula and instructional materials for teaching science in grades K-6. Introduces and examines strategies to differentiate instruction so as to meet the needs of diverse students with a range of
ED 430. College Retention: Theory, Research, and Practice
Introduces students to research and theory regarding college student retention. Explores cultural, institutional, and individual factors that contribute to college student attrition and provides implications for improving college retention practices. (Offered: Fall (even))

EDU 430. Theory and Practice in Teaching and Learning Mathematics in Elementary School
Prerequisites: (Restrictions: Pre-service teachers should take this course concurrently with the 100-hour field experience (e.g., EDF 404 or 405 or 410 or 411))
Prepares teachers to make the learning of mathematics more meaningful and accessible to all students in elementary school. Examines the key questions of what mathematics should be taught, why and how in elementary school, in light of relevant research on the learning and teaching of mathematics, state and national standards, and promising practices. Identifies and analyzes exemplary curricula and instructional materials for teaching mathematics in grades K-6. Introduces and examines strategies to differentiate instruction so as to meet the needs of diverse students with a range of learning styles and abilities. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall)

EDU 431. Theory and Practice in Teaching and Learning English
Prerequisites: (Restrictions: Pre-service teachers must take this course concurrently with the 100-hour field experience)
Prepares teachers to support students’ learning of the English language arts in secondary school. Students learn to apply a perspective of language and literacy as social practice into instructional practices that meet the need of culturally and linguistically diverse learners. They question what should be included in the secondary English language arts curriculum, why, and how it should be taught, in light of relevant research on the learning and teaching of English language arts, state and national standards, and promising practices. Topics addressed include: culturally relevant reading and writing instruction, teaching writing as a process, teaching grammar and vocabulary in context, the role of young adult literature, and authentic assessment of language and literacy skills. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall)

ED 432. Professional Writing and Communications
Explores a range of writing practices and types of texts to engage candidates in persuasive writing that is aimed at reaching teachers, parents, administrators, and faculty. Examines ways to identify audience, purpose, and styles of writing and speaking used in specific contexts and settings, including schools, organizations, and academic courses. Candidates bring real-world experiences to the course and have assignments to produce particular genres of text. (Offered: Occasionally, Spring)

EDU 432. Theory and Practice in Teaching and Learning Social Studies
Prerequisites: [EDU 442 recommended] (Restrictions: Pre-service teachers must take this course concurrently with the 100-hour field experience)
Focuses on how secondary students draw from historical, political, and geographic subject matter to think, learn, and interact, and emphasizes the importance of students’ thinking and learning to reflective social studies teaching practice. Explores contested perspectives on what social studies teaching and curriculum should entail, and what the social and intellectual consequences of adolescents’ social studies learning experiences ought to be. As the first in a sequence of subject matter methods courses, this course introduces teaching candidates to conceptual frameworks and strategies for planning, implementing, and assessing social studies learning experiences. A key priority throughout this course is on preparing teachers to build democratic-participatory learning communities, where discussions of controversial historical and political issues are valued and reinforced. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall)

EDU 433. Student Affairs Administration: Admissions and Financial Aid
This course is designed to tie theory to professional practice in student affairs. Two critical and heavily intertwined areas of higher education administration are admissions and financial aid. This course focuses on the history, underlying philosophies, organizational structures and professional staffing, current issues and future challenges facing these organizations. Guest presentations by practicing professionals will complement class offerings. (Offered: Summer (odd)/A)

EDU 433. Integrating Social Studies and Literacy
Focuses on integrating reading, writing, and speaking as literacy practices and public actions, in the interest of strengthening learners’ understandings of their social circumstances and civic roles. Seeks to both clarify and broaden teaching candidates’
definitions of literacy, drawing from school-based documents, like standards, as well as modes of critical literacy found in communities beyond the school setting. Develops participants’ capacities to use multi-genre texts to engage adolescents in examining and addressing dilemmas related to identity development, social exclusion and inclusion, and power and justice, as they manifest in powerful fictional and non-fictional texts and the world beyond them. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Occasionally, Summer)

**EDE 434A. Literacy Teaching: Urban Settings**

Provides an opportunity to experience teaching literacy in an urban setting. Under the supervision of Warner faculty, interns work with elementary students at John James Audubon School #33, supporting literacy learning in a multitude of ways, including selecting and interpreting assessment and diagnostic tools; determining student strengths and learning styles; developing individualized literacy plans; planning and implementing meaningful, engaging, culturally relevant lessons; choosing appropriate literacy resources and materials; and providing strategic, appropriate literacy intervention. Interns apply their knowledge of theory and research in a practical setting, gain experience in providing reading, writing, and word study instruction, and develop confidence and skill in their teaching abilities. Interns commit to a minimum of six hours a week, including a one-hour seminar class following a schedule set in advance by the instructor. This internship can be repeated multiple semesters. (Offered: Fall, Spring)

**EDE 434B. Literacy Teaching: Urban Settings**

Provides an opportunity to experience teaching literacy in an urban setting. Under the supervision of Warner faculty, interns work with elementary students at John James Audubon School #33, supporting literacy learning in a multitude of ways, including selecting and interpreting assessment and diagnostic tools; determining student strengths and learning styles; developing individualized literacy plans; planning and implementing meaningful, engaging, culturally relevant lessons; choosing appropriate literacy resources and materials; and providing strategic, appropriate literacy intervention. Interns apply their knowledge of theory and research in a practical setting, gain experience in providing reading, writing, and word study instruction, and develop confidence and skill in their teaching abilities. Interns commit to a minimum of six hours a week, including a one-hour seminar class following a schedule set in advance by the instructor. This internship can be repeated multiple semesters. (Offered: Fall, Spring)

**EDU 434A. Master’s Academic Writing**

Prerequisites: (Restrictions: Open to both master’s and doctoral students)

Designed for students seeking to learn master’s-level academic writing. Aims to help students develop their academic writing as they begin their master’s program. The initial modules of this course orient students to the library resources available, introduces referencing requirements of the American Psychological Association (APA), and helps students learn how to cite and provide credit for outside sources in research to avoid plagiarism. Additional modules familiarize students with a variety of writing genres, including reflection journal entries, article critique, annotated bibliography, literature review, research proposal, research paper and other genres they will encounter. This course discusses academic genres such as critical summary, argumentation, and other aspects of well-reasoned academic writing. (Offered: Summer A & B)

**EDU 434A. Theory and Practice in Teaching and Learning Science**

Prerequisites: (Restrictions: Pre-service teachers must take this course concurrently with the 100-hour field experience)

Prepares teachers to make the learning of science more meaningful and accessible to all students in secondary school. Examines the key questions of what should be taught, why, and how in the secondary school science curriculum, in light of relevant research on the learning and teaching of science, state and national standards, and promising practices. Identifies and analyzes exemplary curricula and instructional materials for teaching science in grades 7-12. Introduces and examines strategies to differentiate
EDU 435. Theory and Practice in Teaching and Learning Foreign Languages and ESOL (English to Speakers of Other Languages)  
Prerequisites: [EDU 480, or by permission of instructor] (Restrictions: Pre-service teachers must take this course concurrently with the 100-hour field experience)

Introduces teachers to key issues in the teaching and learning of a second language (foreign language or ESOL) in grades K-12 as well as in other contexts. Builds on research and theory in the fields of learning, teaching, curriculum, and second language education more specifically. Addresses issues about teaching other languages in schools. Includes topics such as literacy, assessment, and technology. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall)

EDU 436. How Universities Work  
Today’s universities are far from simple organizations and do not conform to the traditional organizational models and cultures seen in business, government or even K-12 operations. This course explores the obvious and hidden complexities, interdependencies and organizational challenges of the modern university through a combination of academic content and practitioner presentations by key leaders from the university and higher education. (Offered: Fall)

EDE 436. Diversity and Equity in Education  
Explores global contexts of education to understand the production of social inequalities based on varied identity markers (e.g., race/ethnicity, class, gender, sexual orientation, ability status, and language). Foundational questions include: What do diversity and equity mean in various global P-20 educational contexts? How do histories and politics of schooling, as well as institutional structures impact those definitions? What sources of oppression and marginalization exist in these various educational contexts? (Offered: Fall)

EDU 437. Diversity and Equity in Higher Education  
Examines the educational history of non-dominant populations. Critical race theory will be used to explore the institution of higher education. While race and gender are broad topics, these issues will be complicated with those of class, disability, power, and our role in the power structure. Critical multiculturalism provides the basis for transformation in higher education. (Offered: Spring)

EDU 439. Policy Analysis in Education  
This course takes an interdisciplinary approach to understanding educational policy analysis by drawing from education, public policy/policy sciences, and the social sciences. Readings from educational and non-educational settings are utilized to promote understanding of how public policies are developed, designed, implemented, and changed, as well as the methods associated with public policy analysis. The major requirements for the course include a small group in-depth analysis of an existing educational policy and an individual policy study of an educational problem of interest. (Offered: Fall)

EDU 439. Interpersonal Systems in Counseling and Human Development  
Includes study of the multiple forms of intimate relationship across the life-course, and their role in human development and mental health. Emphasizes the interpersonal systems orientation to counseling in which problems and challenges, as well as their amelioration, are constructed and interpreted as experiences of relationship. Critical concepts from the literatures in family development; friendship and social support; marriage and family counseling; social psychology; and community prevention will be used to illustrate the meanings of, and opportunities for, relatedness in contemporary life for the purpose of learning to construct appropriate and empowering social-systemic counseling interventions for all ages of children and adults who are in relationship to each other. (Offered: Fall)

EDU 440. Urban Teaching & Leadership Seminar 1A  
Prerequisites: [EDE 446] (Restrictions: Students accepted into the UTL Program only, or by permission of instructor)

Building upon the analysis of the sociohistorical contexts of urban education in EDE 446, the fall Urban Teaching and Leadership (UTL) seminar delves more deeply into the institutional, pedagogical, developmental, and policy-related factors that shape life in urban educational spaces. Topics covered include: the experiences of students and educators in urban schools, the social context and systemic problems of school reform, and the insights of community stakeholders on the state of urban education. The course meets five times during fall semester, usually from 10 a.m. to 1 p.m. on Saturdays, with some seminars occasionally rescheduled for weeknights to accommodate guest speakers or special field trips. (Offered: Fall)
**EDE 440. LGBTQ Issues in Education and Human Development**
Addresses current issues related to the education and developmental needs of lesbian, gay, bisexual, transgendered, and queer students in K-12 schools and in higher education. Examines heterosexism, gender oppression, and homophobia in schools, and analyzes schools as sites for transforming or transmitting cultural values/norms related to gender and sexuality. Explores historical, legal, social and political trends that have an impact on schools' ability to address these issues and examines connections and intersections among heterosexism, gender oppression, homophobia, sexism and racism in schools, with a focus on specific concerns of lesbian, gay, bisexual, transgender students, parents, and educators in the educational setting. (Offered: Fall (even))

**EDU 440. Children’s Literature and Literacy Learning**
Prerequisites: [EDU 498 recommended]
Prepares educators to capitalize on children's literature for fostering learning. Focuses on children's literature as a unique context for literacy, linguistic, and literacy learning in the classroom. Explores the field of children's literature and literary analysis by reading, analyzing, and evaluating children’s books representing each major literary genre. Develops questioning techniques designed to enrich children’s experience as readers, to enhance the quality of their responses to literary texts, and to help children develop the strategies necessary to generate meaning as readers and writers. This course is taught as a workshop with several full-day and additional part-day sessions each summer. (Meets content-pedagogy requirement for professional teaching certification.) (Offered: SummerB)

**EDU 441. Urban Teaching and Leadership Seminar 18**
Prerequisites: [EDE 446, ED 440] (Restrictions: Students accepted into the UTL Program only, or by permission of instructor)
Building upon the analysis of the current state of urban education in EDU 440, the spring Urban Teaching and Leadership (UTL) seminar considers conceptual frameworks and practical strategies that have the potential to address a range of dilemmas facing urban schools. Topics covered include: trauma, restorative practices, transformative pedagogies, and issues of equity and access in school improvement. The course meets five times during spring semester, usually from 10 a.m. to 1 p.m. on Saturdays, with some seminars occasionally rescheduled for weeknights to accommodate guest speakers or special field trips. (Offered: Spring)

**EDU 442. Race, Class, Gender, and Disability in American Education**
Explores how and in what ways schools produce inequalities based on socially constructed conceptions of identity (e.g., race, class, gender, gender identity, ethnicity, sexual orientation, (dis)ability, and language). Students will critically analyze relevant literature and their own experiences as raced, classed, gendered, (dis)abled, etc. individuals to develop an understanding of how educational institutions serve as agents of the transmission of social injustice. Students will understand race, class, gender, (dis)ability and other identity markers as intersected and mutually constituted, not as isolated variables. Examines how human diversity shapes and is shaped by our lives, and how the transformation of social and educational practices might re-shape lives. (Offered: Fall, Spring, SummerB)

**EDU 443. Implementing Innovation in English Education**
Prerequisites: [EDU 431, or by permission of instructor] (Restrictions: Pre-service teachers must take this course concurrently with their student teaching experiences; other candidates are expected to find an instructional context where they can conduct the projects included in this course)
Supports students in putting into practice what they learned in EDU 431 to enhance their understanding of teaching practices for the English language arts. Facilitates students’ understanding and deconstruction of, then planning for and enactment of, high-leverage teaching practices within their student teaching placements. Guides students through planning and implementation of instructional units, the evaluation of specific implementations of such units in the classroom, and the assessment of what students are learning as a result of these experiences. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)

**EDU 444. Children’s Literature Across the World**
The focus of this course is on children's literature as the context for literacy, linguistic, and literacy learning in the classroom. Students in this course will learn about the field of children's literature and about literary analysis by reading, analyzing, and evaluating children’s books representing each major literary genre. Special emphasis will be placed on the development of questioning and “think aloud” techniques used as teaching and learning tools and designed to: 1) enrich children’s experiences as readers and writers, 2) enhance the quality of their responses to literary texts, and 3) help them internalize and practice the reading-thinking strategies used by proficient readers. (Offered: Occasionally)

**EDU 444. Implementing Innovation in Mathematics Education**
Prerequisites: [EDU 436, or by permission of instructor] (Restrictions: Pre-service teachers must take this course concurrently with their student teaching experience; other candidates are expected to find an instructional context where they can conduct the projects included in this course)
Supports teachers in putting into practice what they learned in EDU 436 to enhance their understanding of key issues in the teaching and learning of mathematics. Introduces and critically examines innovative teaching methods, curricula, and resources to support the teaching of specific mathematical topics, consistent with the National Council of Teachers of Mathematics (NCTM) standards. Supports students in the planning and implementation of instructional units, the evaluation of specific implementations of such units in the classroom, and the assessment of what students are learning as a result of these experiences. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)
EDE 445. Teaching Students with Significant Disabilities

Prepares teacher candidates to develop appropriate teaching and learning strategies and individualized programs for students with significant disabilities. The emphasis is on teaching and supporting students in accessing the general education curriculum and typical school activities in the general education setting and in their home communities. Candidates examine evidence-based instructional practices, assessment strategies, assistive technology, communication, facilitating peer relationships, and embedding functional skills in the general education curriculum as they develop an understanding of the learning characteristics of this student population. Prepares candidates to identify systemic structures that impede student learning and develop advocacy skills to break down these barriers. (Offered: Spring)

ED 446. Collaborative Teaching Partnerships in Inclusive Classrooms

Empowers teachers to capitalize on the expertise and support of other professionals in addressing the needs of students with disabilities in inclusive classrooms. Explores the nature of collaborative relationships within an educational and social context and how such relationships can be effectively established to support inclusive teaching. Examines historical and current theories and frameworks for collaboration and community building, and strives to have teachers develop a personal model of collaboration and team building with colleagues, parents, and students. (Offered: Spring, SummerB)

EDE 446. Introduction to Urban Education

Prerequisites: (Restrictions: Master’s students enrolled in UTL Program or with permission from instructor.)

The social and historical contexts of urban education in the United States place unique demands on teachers in America’s urban schools. Situated in communities affected by the steady withdrawal of social and economic capital from America’s inner cities, urban educators must acknowledge the impact of late-twentieth century urban decline while not losing sight of the agency and humanity of urban communities, families, and youth. This one-credit course offers an introduction to the political and economic contexts that shape the exigencies of urban schooling, and provides an opportunity for students to begin to consider how their work as educational stakeholders might improve the academic experiences and life chances of young people in urban schools. (Offered: SummerA)

EDU 446. Entrepreneurial Skills for Educators

Engages students in the development of skills and practices that make traditional entrepreneurs successful and examines how these practices can empower educators to be more effective leaders and agents of change. This course especially focuses on entrepreneurial attitudes and behaviors that can help educators expand their abilities to identify and evaluate opportunities, develop and implement carefully considered plans, build coalitions, secure resources, evaluate and manage risks, and create a culture that encourages creativity and initiative. By doing so, students become more effective in promoting innovations that can improve their institutions and better serve their clients. (Offered: Spring, SummerA, SummerB)

ED 447. Disability and Schools

Prepares educators to understand and respond to the needs of students with disabilities. Examines the concept of disability in society and, more specifically, in education. Considers the historical context for special education and the institutional approach to disabilities, and utilizes that context to critically examine and discuss current educational practices, laws, and regulations for students with diverse learning abilities. Addresses the inclusion/standards debate, as well as the diagnosis, classification, and assessment of students. Introduces some strategies for working with students with diverse learning abilities in the typical classroom. (Offered: Fall, SummerA)

EDE 447. Counseling Interventions for Children and Adolescents

Explores counseling interventions suitable for working with children and adolescents. Introduces students to the adaptations to counseling practice that are necessary for successful work with this population, and considers a variety of common problems experienced by young clients. Provides an overview of important socially-mediated developmental issues beginning in early childhood. Familiarizes students with community-based resources for youth and their families. Suitable for students working in school, mental health, or community settings. (Offered: SummerB)

EDU 447. Grant Writing and Other Funding Strategies for Educators

Implementing change and worthwhile initiatives in education most often requires securing the necessary funding. This course prepares educators and other helping professionals to secure such funding. Includes learning about potential funding sources, how to select funding sources appropriate to a specific project, how to write compelling applications to different types of funding sources (including federal and state grants, national and local foundations, private donors, banks and other lending agencies), and how to appropriately steward the funds when awarded. Students are recommended to come to the course with at least one specific project they want to fund, or otherwise will be assigned such a project by the instructor. (Offered: Fall)

EDE 448. Behavior and Communication Supports for Students with Significant Disabilities

Develops a context for current and pre-service teachers to understand disability as a social construct in society at large and in the educational community in particular. Critically examines the historical context for special education and the institutional approach to disabilities, and utilizes that context to discuss current educational practices for students with diverse learning abilities. Addresses laws and regulations affecting the education and inclusion of all students as well as family issues, the inclusion/standards debate, assessment, and labeling, and other issues facing schools. There are 20 additional field hours attached to this course. (Offered: SummerB)
EDU 448. Implementing Innovation in Science Education
Prerequisites: [EDU434, or by permission of instructor] (Restrictions: Pre-service teachers must take this course concurrently with their student teaching experiences; other candidates are expected to find an instructional context where they can conduct the projects included in this course)

Supports teachers in putting into practice what they learned in EDU 434 to enhance their understanding of key issues in the teaching and learning of science. Introduces and critically examines innovative teaching methods, curricula, and resources to support the teaching of science, consistent with state and national standards. Supports students in the planning and implementation of instructional units, the evaluation of specific implementations of such units in the classroom, and the assessment of what students are learning as a result of these experiences. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)

EDE 449. Pre-practicum in Community Mental Health Counseling
Introduces community mental health counseling students to foundational principles and practices encountered in clinical mental health settings. Topics covered include: treatment planning, case conceptualization, documentation, mental health status examination, and intake interviewing. Students are required to implement their new knowledge of clinical practices in a variety of clinical simulation exercises. (Offered: Fall)

EDU 450. Applied Leadership
The course is an intensive leadership practice based learning laboratory designed to broaden and build educational leaders’ capacity and capability for creating, maintaining and growing high engagement schools, systems and organizations. Focus is on individual, team and organization human and systems dynamics that impact organizational functioning. Students gain awareness in, understanding of and important skills in fostering multi-level organizational human ecologies conducive to high commitment, performing organizations. Special attention is paid to building individual capacity to lead, engage and manage change in complex systems. Developing self-reflection habits and the ability for effective peer-to-peer interactions are also important learning outcomes of the course. (Offered: Fall)

EDU 451. Teaching and Learning in Inclusive Classrooms
Prerequisites: [ED 447 (or ED 403 for early childhood students), or by permission of instructor]

Assists teachers by providing critical understanding and skills to meet the needs of all students in inclusive classrooms. Provides an opportunity to critically examine policies and practices for students with disabilities. Focuses on promising practices in the context of general education and curricular reform and provides strategies to assist in collaborative practice and differentiating instruction. (Offered: SummerB)

EDE 451. Organizational Theory: Theoretical Traditions, Future Directions
This seminar course begins to explore the major theoretical traditions in organization theory. The course not only investigates the fundamental questions of organization theory, but also probes how organization theory can advance our understanding of enduring and emerging problems in education. The theories scrutinized in the course include bureaucracy, resource dependence, new institutionalism, population ecology, organizational economics, and networks. (Offered: Fall (odd))

ED 452A. Instructional Strategies for Inclusive Classrooms A
Prerequisites: [ED 447 and ED 451, or by permission of instructor]

Building on what is learned in ED 451, this course further explores and develops appropriate teaching and learning strategies to support all types of students in the classroom. Examines evidence-based instructional practices to understand how people learn and examines differentiated instruction through, among others, the concept of multiple intelligences and strength-based assessment and instruction. Assists teachers in identifying systemic structures that impede student learning and developing advocacy skills to break down these barriers. ED 452A covers standards-based lesson planning, Individualized Education Programs, Response to Intervention, and strategies to differentiate instruction. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall)

ED 452B. Instructional Strategies for Inclusive Classrooms B
Prerequisites: [ED 452A, or by permission of instructor]

Building on what is learned in ED 451, this course further explores and develops appropriate teaching and learning strategies to support all types of students in the classroom. Examines evidence-based instructional practices to understand how people learn and examines differentiated instruction through, among others, the concept of multiple intelligences and strength-based assessment and instruction. Assists teachers in identifying systemic structures that impede student learning and developing advocacy skills to break down these barriers. ED 452B covers strategies to differentiate instruction, universal design for learning, organizing content for learning, adapting assessment and data-driven decision making, and accommodations and modifications. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)
ED 452C. Instructional Strategies for Inclusive Classrooms C
Prerequisites: [ED 452A and ED 452B, or by permission of instructor]

Building on what is learned in ED 451, this course further explores and develops appropriate teaching and learning strategies to support all types of students in the classroom. Examines evidence-based instructional practices to understand how people learn and examines differentiated instruction through, among others, the concept of multiple intelligences and strength-based assessment and instruction. Assists teachers in identifying systemic structures that impede student learning and developing advocacy skills to break down these barriers. ED 452C covers classroom management, collaboration with related services professionals and families, assistive technology, and transitions. (Meets content-pedagogy requirement for professional teaching certification). (Offered: SummerA)

ED 453. Introduction to Applied Behavior Analysis

This is the first course in the Applied Behavior Analysis course sequence and will provide students with a basic understanding of the terminology and applications of ABA. The primary foci of this course are to teach students introductory principles and methods used in ABA and to explore the application of these methods in educational and other settings, including how to apply the practice to improve the quality of life and valued outcomes for individuals diagnosed with an autism spectrum disorder. This course is a co-requisite for all other courses in the ABA sequence, but does not require admission into the program to register. (Offered: Fall, Spring)

EDE 453. Post-Secondary Transition for Youth with Significant Disabilities

Develops a context for current and pre-service teachers to understand and be prepared to meet the needs of secondary students with low incidence disabilities. Covers a wide range of topics related to transition, including historical and philosophical perspectives, transition legislation and policy, transition assessment and its use in student-centered educational and transition planning, interagency collaboration, self-determination, person centered planning, assistive technology, postsecondary education, employment, and other adult activity options, and human services (disability benefits, social security, and adult agencies). There are 20 additional field hours attached to this course. (Offered: Fall, Spring)

EDU 453. Counseling and Facilitating in Small Groups
Prerequisites: [EDU 457]

Explores the dynamics of small groups and their application to the work of counselors. Content includes: human systems; small group dynamics; leadership and membership; group counseling and facilitation; small group techniques and interventions; and the legal and ethical considerations in group work. Students become members of an ongoing growth group that meets regularly as part of the weekly class agenda. (Offered: Fall, Spring, SummerB)

EDE 454. Assessment and Treatment of Challenging Behaviors
Prerequisites: [ED 453]

Assessment and treatment of challenging behaviors is critical to the practice of Applied Behavior Analysis (ABA). In this course, students will gain a fundamental understanding of challenging behaviors and how to address them through the use of ABA. Students will learn to define challenging behavior, along with gaining an understanding of the history of treatment for those exhibiting these behaviors. Students will also learn variations within ABA in the assessment and treatment of the significant challenging behaviors often encountered by Behavior Analysts. Particular attention will be given to behaviors often exhibited by people with autism spectrum disorders. (Offered: SummerA)

EDU 454. Career Counseling and Development
Prerequisites: [Restrictions: Students who are matriculated in the counseling or higher education program, or with permission of instructor]

Provides an overview of the career counseling and development field, including career development theories and decision-making models; career development program planning, organization, and services; career education practices; career counseling materials, processes, and techniques; and computer-assisted career guidance systems. (Offered: Spring, SummerA)

EDE 455. Research Methods in Applied Behavior Analysis
Prerequisites: [ED 453]

Applied behavior analysis, as a discipline for studying and positively impacting socially important behavior, is unique in that its research methods are the same methods utilized in the applied realm. There is an established, field-tested set of methods for analyzing behavior for both purposes. The focus of this course is on foundational research method techniques and their extensions and/or refinements that correspond with the evolution of the field. The course will provide students a thorough overview of applied behavior analysis research methods and “guide” students through the process of developing an (hypothetical) applied behavior analytic research project. (Offered: SummerA)

EDU 455. Policy and Practice in Developmental Differences

Introduces opportunities, support, and resources for individuals concerned with developmental differences and normalcy. Welcomes participants from various positions, interests, and experiences, including health and human service professionals, educators, family members, persons with developmental differences, and scholars. Oriented by a developmental, life-long, and multi-disciplinary approach, participants work to dispute dominant disability discourses of ‘lacks and absences’ and to reconsider developmental differences as neither inherent nor ‘less than’ what is needed. (Offered: Fall)
EDE 456. Ethical and Professional Conduct for Behavior Analysts
Prerequisites: [ED 453 (or concurrently)]

The profession of behavior analysis is undergirded by well-specified ethical and professional conduct guidelines. This course provides a foundation in ethical and professional conduct for the developing behavior analyst. The field’s professional conduct code, as primarily detailed in the Guidelines for Responsible Conduct of the Behavior Analyst Certification Board, serves as a basis for much of the course’s content. A special, though not exclusive, emphasis is placed upon ethical conduct with individuals with autism spectrum disorder and other developmental disabilities, as well as other unique learning needs. (Offered: Fall)

ED 457. Autism Spectrum Disorders: Characteristics and Educational Issues

Introduces the autism spectrum and the associated behavioral and learning characteristics. Explores the history of spectrum disorders, the current etiological theories, and the issues surrounding diagnosis, assessment, and treatment. Focuses on the characteristics of autism spectrum disorders; the historical context of the spectrum of disorders with particular emphasis placed on the diagnostic issues and debates; current theories and research into causes of the disorders; best practices in the assessment of children with a spectrum disorder; the learning characteristics of children with a spectrum disorder; and an introduction to and discussion of educational intervention models. (Offered: Spring)

EDE 456.

EDU 457. Counseling Theory and Practice I
Prerequisites: [EDU 450 or EDU 472 concurrently]

Introduces the major theories of counseling and their relationships to its practice in a variety of settings. Addresses the historical development and views of human nature for each theory, as well as the counselor’s role in facilitating change. Introduces basic interviewing and counseling skills and integrates theoretical approaches with skill development for counseling practice. Considers counseling ethics and multicultural awareness. (Offered: Fall)

ED 458. Methods and Applications in Applied Behavior Analysis
Prerequisites: [ED 453]

Provides students with a conceptual understanding of how behavior analysis can be applied in educational and other human service settings, including service delivery models and factors contributing to program quality. Topics covered include: skill-building methods in the areas of social skills, language and communication, self-care, play and classroom skills, supervision, and staff training and management. (Offered: Spring)

EDE 458.

EDE 458.

EDE 458.

EDE 458.

EDE 458.

EDU 459. Client Confidentiality and Records Management

Addresses client confidentiality and strategies for maintaining client records, highlighting regulations governing this process. In any clinical or educational endeavor, maintaining client confidentiality and secure records is an essential skill. Instructional, clinical, and behavioral change intervention efforts result in client-specific products and other treatment/intervention data. These data, which are essential to good treatment, used to justify reimbursement, and shared where appropriate, must also be protected. (Offered: Spring)

EDU 459.

EDU 459.

EDU 459.

EDU 459.

EDU 459.

EDE 460. Master’s Culminating Requirement: Ed Administration K12

(Offered: Fall, Spring, Summer)
EDU 460. Counseling Theory & Practice II  
Prerequisites: [EDU457]  
A continuation of Counseling Theory and Practice I. Enhances counseling and communication skills and knowledge of the counseling relationship. Prepares and supports students in their Practicum in Counseling (EDU 458), which may be done concurrently. (Offered: Spring)

ED 461. The Politics of Education  
Introduces candidates to the recurrent forces and competing values that shape decision making in local school districts, focusing on the local level of educational politics. Examines the role of school boards, parents, teachers unions, mayors, and others. Provides candidates with the knowledge and skills necessary to work effectively as education leaders in this political environment. (Offered: Spring)

EDE 461. Master's Culminating Requirement: Higher Education  
All Higher Education students are required to complete a culminating experience to graduate, either by writing a Master’s thesis/paper (0 to 3 credit hours) or passing a comprehensive examination (0 credits) near the end of their program. Students choosing the thesis/paper option can complete it using the spring semester cohort-based seminar or while registering for ED 493 Master’s Research hours and working with their advisor or other Higher Education faculty member any term toward the end of their degree program. Those choosing the comprehensive examination can arrange the examination with their advisor during their final semester. An “S” (satisfactory) grade for EDE 461 indicates completion of the culminating requirement. (Offered: Fall, Spring, SummerA & B)

ED 462. Managing School Resources  
Provides students with the skills needed to manage school resources (both fiscal and physical) effectively. Prepares students to prepare a budget for school, programs, and activities and to conduct a cost analysis. Addresses resource management issues in specific program areas, including cash management and inventory, risk management, scheduling and enrollment management, and facilities and maintenance. (Offered: Spring)

EDU 462. Implementing Innovation in Social Studies Education  
Prerequisites: [EDU432, or by permission of instructor] (Restrictions: Pre-service teachers must take this course concurrently with their student teaching experiences; other candidates are expected to find an instructional context where they can conduct the projects included in this course)  
Supports teachers in putting into practice what they learned in EDU 435 to enhance their understanding of key issues in the teaching and learning of a second language. Introduces and critically examines innovative teaching methods, curricula, and resources to support the teaching of foreign languages and ESOL, consistent with state and national standards. Supports students in the planning and implementation of instructional units, the evaluation of specific implementations of such units in the classroom, and the assessment of what students are learning as a result of these experiences. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)

EDU 463. Implementing Innovation in Foreign Languages and ESOL Education  
Prerequisites: [EDU435, or by permission of instructor] (Restrictions: Pre-service teachers must take this course concurrently with their student teaching experiences; other candidates are expected to find an instructional context where they can conduct the projects included in this course)  
Supports teachers in putting into practice what they learned in EDU 435 to enhance their understanding of key issues in the teaching and learning of a second language. Introduces and critically examines innovative teaching methods, curricula, and resources to support the teaching of foreign languages and ESOL, consistent with state and national standards. Supports students in the planning and implementation of instructional units, the evaluation of specific implementations of such units in the classroom, and the assessment of what students are learning as a result of these experiences. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Spring)

EDU 464. State and Federal Education Policy  
Studies state (emphasis on New York) and federal policy process for K–12 schools. Candidates learn to identify problems and challenges in policy design and implementation by examining the construction of policy problems, the instruments used, and the theories and assumptions underlying policies. Drawing on literature from political science, sociology, and educational policy, the course provides students with skills to analyze education policies and infer their implications. Policy discussions include the Every Student Succeeds Act, Common Core and other state standards, choice and accountability policies, issues related to high-stakes testing, and other current policy issues at the state or federal level. (Offered: Spring (even))

EDU 464. Child Development and Learning in Context (ages 5 to 12)  
Develops an understanding of what can be expected of children five to 12 years old. Examines the development of children from theoretical and empirical perspectives, emphasizing the role of a wide range of contextual factors in children's development. Examines research trends and findings in the areas of language development, social development, intellectual development, learning, and achievement motivation. Distinctions between informal and formal learning provide a context for exploring the role that formal schooling can play in learning and development. (Offered: SummerA)
ED 465. School Governance and the Rights of Students and Teachers

Provides an overview of legal principles and rules of particular relevance to school building administrators and introduces issues of applied ethics. Answers those legal questions of most relevance to school building administrators. Develops skills in the interpretation and application of law to school situations. Provides insight into some fundamental issues addressed by school law and ethical dilemmas of relevance to school leaders. (Offered: Spring)

ED 465. Master’s Essay: TESOL

Designed to guide students through the process of writing master’s essays, the workshop format provides practical support at all levels of the writing process, from identifying and narrowing a topic for research to final, APA compliant formatting. Purpose, focus, structure, voice, style, grammar, referencing and citations, and formatting will be discussed. By the end of the course, students will have a full draft of their thesis completed and will have followed steps which help to avoid common pitfalls, save time, and improve writing quality. (Offered: Fall, Spring)

EDU 465. Assessment and Appraisal

Explores the fundamentals of selecting, administering, interpreting, and presenting tests as a component of the diagnostic and counseling process. Includes discussions of the principles of measurement, an examination of intelligence, career, personality, and other test instruments; rationale for test selection; guidelines for test administration; and ethical use of appraisal in decision making and treatment planning. (Offered: Fall, Spring)

ED 466. Leading Change in Education

The course is an intensive learning laboratory designed to broaden and build leaders’ capacity and capability for creating, maintaining, and growing high engagement schools, systems, and organizations. Focus is on individual, team and organization human and systems dynamics that impact organizational change. Students gain awareness in, understanding of, and important skills in fostering multi-level organizational human ecologies conducive to high commitment, performing organizations. Special attention is paid to building individual capacity to adaptively lead, engage, and manage change in uncertain times and with complex systems. Developing self-reflection habits and the ability for effective peer-to-peer interactions are also important learning outcomes of the course. (Offered: Occasionally)

EDU 466. Educational Legal Theories and Policies

From the perspective of the legal system, examines students’ rights and efforts to achieve equal educational opportunity in public K-12 school systems. Topics explored include students’ civil liberties, such as free speech and due process rights; legal efforts to achieve desegregated schools; equitable school funding; and legal rights of students in the special education process. Also examines the structure of the legal system and the role of legal precedent in the context of K-12 education. (Offered: Spring)

EDU 466. Problem Identification and Intervention in Counseling I

Focuses on identification and treatment of clinical problems that students may encounter as practicing mental health or school counseling professionals. Introduces a variety of diagnostic systems and methods for constructing remediation and prevention strategies. Contents of the Diagnostic and Statistical Manual of Mental Disorders-V are introduced, and opportunities are provided to make diagnostic assessments and treatment planning strategies through the use of confederate case clients. DSM-V categories covered include: anxiety disorders, depressive disorders, personality disorders, attention-deficit hyperactivity disorder, reactive attachment disorder, trauma- and stressor-related disorders, and bipolar and related disorders. (Offered: Fall)

ED 467. Student Affairs Administration: International Student Affairs

This course is designed to tie theory to professional practice in student affairs. Focuses on both the practices and philosophy of working with international students on campus. Examines governmental policy changes since 9/11 and their impact on higher education and issues related to immigration advising, career counseling, cross-cultural advising, student advocacy, crisis management in a cross-cultural setting, intercultural programming, publications and forms, ethics, and the legal responsibilities of those advising international students. (Offered: Summer (even)B)

EDU 467. Language, Literacy, and Cognitive Development

Develops an understanding of how children develop oral communication, reading, writing, and other literacy skills, and how this development can be supported and enhanced. Explores how children acquire, use, and expand their competence with language from infancy through their first years in elementary school. Examines the theory and research on the cognitive bases for language acquisition, the sequences of intellectual development that characterize infancy and early childhood, the nature of language-based interactions with others in the immediate environment, and the uses of language in the wider community. (Offered: Spring)

ED 468. Leadership in Urban Schools

Focuses on teaching, leadership, and administration in urban school settings. Candidates investigate the realities and misconceptions of these environments and probe and clarify their own conceptions of, and attitudes toward, urban schools. Candidates draw on theoretical literature, empirical research, case studies, the personal experience of others in the class, and the community to think about ways to apply theory to practice. Engagement with administrators, teachers, students, and community members who work and/or live in the City of Rochester is a requirement of this course, and opportunities for this interaction will be made available during and outside of course meetings. (Offered: SummerA)
EDU 468. Data-Driven School Improvement
School leaders are increasingly immersed in data. It is imperative that they understand what role data can play in creating places of learning. Participants will develop their own research-based theory of change relative to the role of data in the improvement of student learning and schools. Specifically, participants will answer the question, “How can data best be used to further the goals of schools?” Students complete a simulation of a data-based improvement planning process. (Offered: SummerB)

ED 469. Leadership and Organizational Dynamics
Examines organizational theory and dynamics focusing on school as a complex organization, emphasizing school culture and the change process in schools. Explores leadership theory and models to help participants understand and prepare for leadership. (Offered: Winter, Spring)

EDU 470. Topics in Online Teaching (Offered: SummerA)

EDU 470. Multicultural Perspectives in Counseling
Addresses issues of culture, ethnicity, gender, ability, sexual orientation, age, and social class in relation to current counseling theory and practice. Students examine their own cultural identities and values and how these may impact their work as counselors serving diverse populations. Issues include recognition/acceptance of diversity; knowledge of multicultural issues and concepts; knowledge of specific cultural and racial/ethnic groups; personal, institutional, sociopolitical responses to diversity; and communication and counseling skills for diverse populations. (Offered: Spring, SummerA)

EDU 471. Counselor as Systems Consultant
Prerequisites: [EDU 453, EDF 450 or concurrently] (Restrictions: )
Explores the different consultation and advocacy processes needed to identify and overcome organizational and institutional barriers that impair the development of individuals, small groups, and larger social units, with an emphasis on equity and successful identity achievement. Gives primacy to a social systems view of schools and community agencies, and focuses on developing proficiency in systems analysis and strategies for implementing system changes. Theories and models of consultation to systems are introduced and incorporated into practice. (Offered: Fall (odd), Occasionally)

EDU 472. Principles and Practices of Community and Mental Health Counseling
Provides an introduction to the counseling profession with an emphasis on the counselor’s role in community agencies and facilities. Examines the responsibilities of the community counselor from a historical, theoretical, ethical, and practical point of view. Explores the helping relationship, the roles of the community counselor, and the professional practice issues related to providing community counseling services, historically and today. Focuses on the fundamental elements of basic listening and communication skills that serve as the building blocks for more advanced counseling skills. (Offered: Fall)

EDE 473. Mental Health Issues in School Settings
Offers a framework for understanding maladaptive behavior and psychological distress in children and youth. Focuses on the symptoms, causes, and treatment of a range of psychological challenges commonly encountered in school settings. Provides an orientation to the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition, particularly as it pertains to disorders seen in school-age clients. (Offered: Fall)

EDU 473. Problem Identification and Intervention in Counseling II
Prerequisites: [EDU 466] (Restrictions: )
A continuation of Problem Identification and Intervention in Counseling I. Students are introduced to additional Diagnostic and Statistical Manual of Mental Disorders-V categories, including: schizophrenia spectrum and other psychotic disorders, feeding and eating disorders, dissociative disorders, neurocognitive disorders, substance-related and addictive disorders, gender dysphoric disorder, and paraphilic disorders. A variety of interventions are considered and opportunities are provided to make diagnostic assessments and construct treatment plans through the use of confederate case clients. (Offered: Spring)

ED 474A. Implementing Reform-based Science Education - A
Prerequisites: (Restrictions: Permission of instructor required)
This course is designed to engage participants in collectively articulating and implementing a socially just vision for science education. We work together throughout the three consecutive parts of the course to develop and carry out action research that systematically and iteratively informs practice in a specific context while engaging the broader community in important conversations about needed change, its warrant and accompanying challenges. Sections B & C are offered in following fall and spring. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Occasionally)

ED 474B. Implementing Reform-based Science Education - B
Prerequisites: [ED 474A] (Restrictions: Permission of instructor required)
This course is designed to engage participants in collectively articulating and implementing a socially just vision for science education. We work together throughout the three consecutive parts of the course to develop and carry out action research that systematically and iteratively inform practice in a specific context while engaging the broader community in important conversations about needed change, its warrant and accompanying challenges. Sections A & C are offered in preceding summer and following spring, respectively. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall, Occasionally)
ED 474C. Implementing Reform-based Science Education - C
Prerequisites: [ED 474A & 474B] (Restrictions: Permission of instructor required)
This course is designed to engage participants in collectively articulating and implementing a socially just vision for science education. We work together throughout the three consecutive parts of the course to develop and carry out action research that systematically and iteratively informs practice in a specific context while engaging the broader community in important conversations about needed change, its warrant and accompanying challenges. Sections A & B are offered in preceding summer and fall, respectively. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Occasionally, Spring)

EDE 474. Faculty Online Teaching Preparation Sequence
(Offered: Summer A & B)

EDU 474. Addictions Counseling and Prevention
Introduces the field of addictions counseling and prevention. Surveys the current state of addictions in the United States; examines epidemiological perspectives and etiological theories; explores current forms of treatment, assessment, diagnosis, prevention, and clinical research; and discusses the legal, ethical, and professional issues related to the practice of addictions counseling. (Offered: Spring)

ED 475. Leadership and Management in Higher Education
The primary purpose of this seminar course is to help students develop their own leadership and management skills. Key concepts covered include navigating organizational structures, organizational culture and organizational politics, as well as crafting strategy, becoming an agent of change, and working in teams. Students explore classic texts from inside and outside of education on leadership and management. (Offered: Spring)

EDE 475. Infant Mental Health
This course focuses on the theory and practice of multi-disciplinary Infant Mental Health, and Infant- Parent Psychotherapy. Attachment theory, social-emotional health development of children 0-3 years old, risks and protective factors in infant development, particularly trauma and attachment disruptions, assessment and diagnosis of the parent-infant relationship, IMH interventions, and self-reflective capacity of the IMH professional will be covered. (Offered: Occasionally)

EDU 475. Early Interventions for Children with Disabilities
(ages 3 to 5)
Assists teachers in meeting the needs of preschool children with disabilities. Critically examines the current service delivery system for early childhood education with young children with a disability. Building on an understanding of typical development in three- to five-year-old children, with a focus on understanding those disabilities affecting that development, this course examines developmentally appropriate practices for children with disabilities within the context of an inclusive child- and family-centered curriculum and provides strategies to promote the growth of social and emotional development in children within a continuum of educational settings. (Offered: Spring (even))

ED 476. Administration of Student Affairs in Higher Education
Introduces the history, philosophy, and purposes of student affairs and student services administration. Examines the theoretical and practical foundations of the student affairs profession. Explores issues and problems currently facing student affairs administration in the larger context of an ever-changing environment and the future of student affairs as higher education evolves. (Offered: Fall)

EDE 476. Teaching English Learners in Content Classrooms
Prerequisites: Student teaching completed for pre-service teachers
This course serves as an overview for in-service teachers and pre-service teacher candidates in a range of content areas who work with English language learners (ELLs) in their content classes. The course will introduce students to key concepts of language learning, cross-cultural communication, methods of teaching English, and language assessment. Students will engage in analysis, application and adaptation of teaching methods, materials, and strategies to support instruction for linguistically and culturally diverse students in their own content classes. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Summer B)

EDU 476. Early Intervention for Children with Disabilities (ages birth to 3)
Assists teachers in meeting the needs of infants and very young children with disabilities. Critically examines the current service delivery system for early childhood education to young children with a disability. Building on an understanding of normal development in children from birth to three years old with a focus on understanding those disabilities affecting that development, this course examines developmentally appropriate practices for children with disabilities within the context of an inclusive child- and family-centered curriculum and provides strategies to promote the growth of social and emotional development in children within a continuum of educational settings. (Offered: Summer (odd) B)

EDE 477. Teaching and Learning in the Content Areas
Introduces teacher candidates and in-service teachers to key issues in learning and teaching specific content areas, with particular foci on mathematics, science, and history/social studies. Identifies and critically examines what it means to think and learn within and across particular disciplines, within implications for designing and enacting pedagogies that focus on meaningful learning and accessibility to all students. Consists of several innovative, modeled learning experiences, led by experts in each subject matter, alongside critical examinations of K-12 learning experiences and curricular, and instructional materials. The course is especially relevant to “generalists” who will
be expected to support students’ learning in all subjects, but could also be valuable to teachers interested in interdisciplinary collaborations, education professionals playing instructional support roles, and teacher candidates who want to explore alternative specializations before making a decision. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Fall)

**EDE 478. Integrating Expressive Arts into Counseling Practice**
Expressive Arts Therapy is the use of art, music, psychodrama, writing and poetry, guided meditation, ritual and play in counseling with individuals and groups. This course will explore its use in counseling with children, adolescents, adults and elders. This course will consist of experiential activities and didactic learning experiences. (Offered: Summer (odd))

**ED 479. Human Capital Management in Higher Education**
Discusses the full spectrum of human capital issues facing modern leaders in complex organizations, including the development of employment criteria and the establishment of post-retirement benefits. Includes active discussion of various topical areas and utilizes the case analysis approach. (Offered: Occasionally)

**EDE 479. Assessment, Accreditation and Accountability in Higher Education**
Questions of quality and accountability permeate the higher education landscape. The purpose of this course is to explore the practices and issues connected to assessment of student outcomes and institutional effectiveness in postsecondary contexts. Students will explore a variety of assessment methods and techniques, examine the underlying rationales and political considerations of accountability in higher education, and engage in practical application of assessment strategies. (Offered: Fall (even))

**EDU 479. Promoting Mental Health in Midlife and Old Age**
Prerequisites: (Restrictions: Open to students who are not matriculated in the counseling program and human development gerontological concentration only with permission of instructor)
Focuses on challenges affecting psychological wellness that are commonly encountered in aging populations. Students consider the responses of older adults to socioeconomic constraints, grief and loss, chronic illness, retirement, changing identity, increasing dependency, loneliness, death and dying, and structural ageism. Attention is given to DSM-V diagnostic categories particularly germane to later life and to the unique manifestations of common mental disorders in aging adults. Students are introduced to assessments and intervention strategies specifically designed for use in older adults. Other topics germane to late life are explored, including assisted living, long-term care, and elder abuse. (Offered: Spring (odd))

**EDU 480A. Theory and Practice of Teaching and Learning the Arts in Elementary School (Part 1) (2 credits)**
Provides elementary teachers with opportunities to learn and practice the skills needed to teach the arts effectively, and to integrate them into other curricular areas, including English language arts, social studies, mathematics, science, and technology. (This is the first section of a two-part course; EDU 480B in the fall builds on assignments completed in EDU 480A in the summer.) (Offered: SummerA)

**EDU 480B. Theory and Practice of Teaching and Learning the Arts in Elementary School (Part 2) (1 credit)**
Prerequisites: [EDU 480A]
Provides elementary teachers with opportunities to learn and practice the skills needed to teach the arts effectively, and to integrate them into other curricular areas, including English language arts, social studies, mathematics, science, and technology. (This is the second section of a two-part course; EDU 480B builds on assignments completed in EDU 480A. It is a 1 credit-hour, field-based project to be completed over the following fall semester after completing EDU 480A during the previous summer A.) (Offered: Fall)

**EDU 480. Second Language Acquisition and Bilingualism**
Provides an understanding of how people learn a second language, as a foundation for examining effective ways to teach foreign languages and ESOL. Introduces theories and research on second language acquisition and bilingualism. Examines the major theories of second language acquisition (SLA) and considers developmental stages and individual differences within second language learning. Surveys models of bilingual education, typologies of bilingualism in individuals, societal contexts for bilingual education, as well as the history and politics of bilingual education in the United States. Explores the applicability of the research on second language learning and bilingualism to classroom instruction. (Offered: Fall, Spring, SummerB)

**EDU 480. Contemporary Issues in Student Affairs**
Explores contemporary issues in student affairs in higher education. Students will explore issues impacting the practice of student affairs such as globalization, accountability, finances, and today’s diverse student. The role of professional organizations will also be addressed. (Offered: Occasionally)

**EDU 481. School, Family, and Community Relations**
Surveys approaches for uniting schools, families, and community institutions into meaningful partnerships to foster academic success and healthy development in young people. Examines theoretical, political, and practical issues and research associated with new and traditional forms of collaboration. (Offered: Fall (even))
**EDU 481. Integrating English and Technology**

Engages teachers and teacher candidates in a critical examination of the affordances and integration of technology in classroom practices, across the disciplines. Assists participants in developing guiding principles for designing instruction with technology and exploring the opportunities and constraints of various online spaces, software, applications, and other technology that can support the teaching in particular content areas. Provides opportunities for participants to practice designing with technology and develop a technology philosophy as part of this course. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Summer (odd)B)

**EDU 482. Technology and Higher Education**

Provides students with an introduction to contemporary topics in information technology that are important to higher education institutions and their leaders. Explores areas of administrative computing, academic computing, IT infrastructure, networking and communication, IT issues and policy development, and other important application areas. (Offered: Fall (odd))

**EDU 482A. Integrating Mathematics and Technology**

Prepares mathematics teachers to capitalize on reading, writing, and other forms of literacy to enhance their students’ learning of mathematics. As students engage as learners in literacy-rich instructional experiences dealing with challenging mathematical topics, they also further their understanding of some fundamental mathematical concepts and ideas. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Occasionally, Summer)

**EDU 483. Communication and Counseling Skills for Teachers, Administrators, and Other Helping Professionals**

Introduces the educating or allied helping professional to the basic skills and core perspectives of counseling as a form of communication. Assists educators in facilitating effective interpersonal interactions by introducing them to basic listening skills, principles of group dynamics, theories of cross-cultural communication, and conflict-resolution strategies. (Offered: Fall)

**EDU 484. Integrating Mathematics and Technology**

Engages teachers and teacher candidates in a critical examination of the affordances and integration of technology in classroom practices, across the disciplines. Assists participants in developing guiding principles for designing instruction with technology and exploring the opportunities and constraints of various online spaces, software, applications, and other technology that can support the teaching in particular content areas. Provides opportunities for participants to practice designing with technology and develop a technology philosophy as part of this course. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Summer (odd)B)

**EDU 484A. Digitally-Rich Teaching and Learning in K-12 Schools**

Empowers participants to appreciate the transformative potential of digitally-rich teaching and learning and to use that potential to design effective “digitally-rich” learning experiences for K-12 students. Digitally-rich teaching and learning (DTL) is defined as creating student-centered learning activities that take full advantage of the learning opportunities offered by a combination of technologies leveraging digital learning, including most notably the use of personal computing devices, learning management systems, specialized software and apps, and a variety of digital resources. Explores the implications for K-12 schools of a coordinated and sustained use of DTL in the context of district-wide efforts toward “digital conversion.” This course is offered as a hybrid online course to enable students to personally experience several different types of synchronous and online learning activities outside of class, and how they can be integrated with in-class and other face-to-face activities. (Offered: Fall)

**EDU 484B. Student Affairs Administration: Residential Life**

This course is designed to tie theory to professional practice in student affairs. Provides an introduction and overview of student residential living and residential life administration in American higher education, including history and theories, student experiences, organization and administration, technology, current issues, and future challenges. (Offered: Summer (even)A&B)

**EDU 484C. Online Teaching and Learning**

Provides masters-level and doctoral-level students with an introduction to the theory and practice of online teaching and learning, with a focus on higher education and professional
development. Students in this course will have the opportunity to personally experience various forms of online learning, and use these shared experiences to examine the potential and limitations of each for diverse learners; they will benefit from the wisdom of practice shared by a number of guest speakers who have engaged in various forms of online teaching; and they will also learn from developing an applied project around online teaching that links theory with practice. By the end of this course students will have a foundation for designing and delivering online learning modules in a way that supports student engagement, student reflection, and active instructor involvement. (Offered: Fall, Spring)

ED 485. College Students and Student Development Theory
The primary purpose of this seminar course is to help students develop their own leadership and management skills. Key concepts covered include navigating organizational structures, organizational culture and organizational politics, as well as crafting strategy, becoming an agent of change, and working in teams. Students explore classic texts from inside and outside of education on leadership and management. (Offered: Spring)

EDU 485. College Access and (In)Equity
Addresses theories and research on a variety of issues related to college preparation, school structures, and inequalities in college access. The course is organized into three levels of analyses: individual levels (e.g., race, ethnicity, and social class), organizational levels (e.g., family, geography, high school context, and outreach), and field levels (e.g., financial aid, testing, rankings, media, and affirmative action). Special attention will be paid to the sociocultural context, particularly on the role of families. (Offered: Occasionally)

EDU 486. Integrating Science and Technology
Prepares secondary science teachers to effectively use technology to enhance science instruction, while furthering their understanding of fundamental ideas and concepts in science. Examines educational technology as a teaching and learning tool in science instruction and how technology may affect instructional goals and teaching practices in science education. Introduces and critically examines software, equipment, and other technological resources that can support the teaching of various scientific subjects and topics. (Meets content-pedagogy requirement for professional teaching certification). (Offered: SummerB)

EDU 487. The Role and Function of the American Community College in Higher Education
The role and function of the American community college is impacted by the interests of constituencies, such as states and localities, workforce needs, students, faculty, administrators, trustees, and other institutions of higher education. Examines the educational, economic, political, and social forces that have influenced the development of the American community college. Addresses organizational culture, curriculum, student services, and current issues and trends that impact the current state and future development of the community college. (Offered: Spring (even))

EDU 488. Integrating Science and Literacy
Prepares science teachers to effectively use reading, writing, and other forms of literacy to enhance science instruction. As students engage as learners in literacy-rich instructional experiences dealing with scientific topics, they also further their understanding of some fundamental scientific ideas and concepts. (Meets content-pedagogy requirement for professional teaching certification). (Offered: SummerA)

EDU 489. Digital Conversion in K-12 Schools
Prepares students to successfully engage in digital conversion—a radical transformation a growing number of K-12 school districts are engaging in—that involves leveraging the combination of 1:1 computing devices, a school-wide learning management system, and a variety of digital tools and resources, to develop more effective teaching and learning practices. Students will “experience as learners” the potential of digitally-rich teaching and learning, and explore its implications for designing and implementing more effective learning experiences for their students through a combination of multi-media readings, in-class and online discussions, and hands-on projects. Based on these personal
ED 490. Genesee Valley Writing Project  
Prerequisites: (Restrictions: Registration by invitation only)  
(Offered: SummerB)

EDU 490. Higher Education Law  
Investigates legal concepts and issues in higher education as a guide for improved understanding and management of institutions and as an opportunity to consider the role higher education plays in society and the effect society’s rules have on higher education. Introduces the legal system and law of higher education governance. Illuminates common legal and educational management and policy issues in higher education, with an emphasis on student and faculty issues. Develops basic problem-solving skills. Provides insight into broader constitutional and policy issues. (Offered: Spring (odd))

ED 491. Independent Study in Education - Master’s Level (variable credits)  
Prerequisites: (Restrictions: Permission of instructor required)  
This option is the one most commonly used by students who are interested in studying a particular topic through independent readings and other activities. The specific nature of the study and criteria for evaluation need to be articulated in writing within the first two weeks of the semester by using a specific Independent Study Form that requires the signature of the faculty member supervising the study, as well as the program chair and associate dean of graduate studies. (Offered: Fall, Spring, SummerA & B)

ED 492. Field Study in Education - Master’s Level (variable credits)  
Prerequisites: (Restrictions: Permission of instructor required)  
This option can be used by all students (other than doctoral students) who are interested in engaging in a supervised project or field experience relevant to their program. (Offered: Fall, Spring, SummerA&B)

EDE 492. Integrating Technology in Teaching Content Areas  
Engages teachers and teacher candidates in a critical examination of the affordances and integration of technology in classroom practices, across the disciplines. Assists participants in developing guiding principles for designing instruction with technology and exploring the opportunities and constraints of various online spaces, software, applications, and other technology that can support the teaching in their own content area(s). Provides opportunities for participants to practice designing with technology and develop a technology philosophy as part of this course. (Meets content-pedagogy requirement for professional teaching certification). (Offered: SummerB)

EDU 492. Governance, Policy, and Administration of Higher Education  
Students gain a deeper and more nuanced perspective on the nature of colleges and universities as organizations. This seminar course helps students become more sophisticated analysts and interpreters of colleges and universities, particularly with respect to the contours of senior decision-making and organizational change. Key questions addressed throughout the course include: what considerations shape the decision-making of senior administrators, such as presidents and provosts, and other key stakeholders, such as trustees and faculty? What tensions arise from the competing interests of key stakeholders? Who – if anyone – is in control of colleges and universities? To what extent can anyone change a college or university? (Offered: Fall)

ED 493B. Master’s Research Abroad  
Master’s students conducting research abroad should register for this research category. (Offered: Fall, Spring)

ED 493. Master’s Research (Master’s Paper, Master’s Thesis, Master’s Essay) (variable credits)  
Prerequisites: (Restrictions: Students must secure the agreement of thesis sponsor)  
Master’s students who are required to prepare a Master’s Essay, or have chosen to fulfill this requirement by preparing a Master’s Thesis, can enroll in this registration. Done on an independent study basis, students must secure the agreement of their Master’s Paper/Thesis sponsor for this project. (Note: Students have the option to register for 0-6 credits.) (Offered: Fall, Spring, SummerA & B)

EDE 493. Navigating Illness with Children and Families: A Child Life Approach  
Takes a theoretical, evidence-based, and practical approach in addressing how professionals in hospitals, schools, and other contexts can best support patients and families in navigating through illness. Explores conceptual frameworks, including socio-ecological approaches, life course, and sociocultural theories. Students build on experiential learning from a variety of site visits, including hospital, therapeutic, and play settings. This course satisfies requirements for becoming a Certified Child Life Specialist, is taught by a CCLS, and meets the six required topics of study set forth by the Child Life Council (child life documents, scope of practice, impact of illness, injury and healthcare on patients/families, family-centered care, therapeutic play and preparation.) A Child Life Course Verification Form is issued at the end of the course. (Intended for students in the areas of child life, nursing, school counseling, medicine, education, mental health, and other health professions.) (Offered: Fall, Occasionally)

EDU 493. History of Higher Education  
Provides a historical survey of, and examines critical issues in, the evolution of American higher education, beginning in the colonial era and extending to the present. This course explores
the development of higher education through six major time periods. Within those time periods, a number of perspectives are considered, including the changing curriculum, the role of the faculty, the experience of the student, the progress of the institution, and other social and economic factors. Key milestones or landmark events are highlighted and studied in more depth. (Offered: Fall (odd))

ED 494. Research & Praxis in Human Development  
(Offered: Fall, Spring)

EDE 494. Counseling and Human Sexuality  
Aims to develop students' knowledge base related to human sexuality; an understanding of the varied sexuality issues that may be encountered in professional counseling practice; students' skills in assessment and intervention skills with sexuality issues; and an increased awareness of one's personal perceptions, attitudes and affect related to sexuality issues. This course is designed for counseling and human service professionals whose work brings them in contact with clients experiencing problems and concerns with their sexuality. (Offered: Occasionally)

EDU 494. Adult Development and Aging  
Examines adult development as a dynamic complex shaped by individual and sociocultural processes that include biological and intrapsychic processes, as well as issues of gender, ethnicity, social status, life experience, sexual orientation, and health/illness. Sociocultural ecologies of adult development, such as families, communities, and societies, will be explored relative to developmental needs and resources of young, middle-aged, and older adults. Introduces participants to a spectrum of community resources involved in supporting well-being across the life-span. (Offered: Fall)

EDU 495. Theory and Practice for Reading Professionals  
Prerequisites: [Course must be taken concurrently with EDF 422; EDU 498 recommended] (Restrictions: For Reading and Literacies students, or by permission of instructor)

Prepares reading and literacy candidates to be knowledgeable and reflective about current strategies to support reading and literacies in schools. Current debates in the field of language and literacy learning will be addressed and situated in practical classroom applications and strategies. Provides an opportunity for students to use their theoretical knowledge to construct meaningful teaching practices in the context of a case study of a student in their practicum. Facilitates a deep understanding of the inseparability of theory and practice in literacy education. (Offered: Spring)

ED 496. Research Apprenticeship - Master's Level (variable credits)  
Prerequisites: (Restrictions: Permission of instructor required)

This option should be used by master's students who are engaging in a research apprenticeship by participating in a scaffolded role in an existing research project directed by a Warner faculty member (with permission and under the supervision of that faculty member). (Offered: Fall, Spring, SummerA & B)

EDU 496. Fiscal Issues in Higher Education  
Introduces the financing and economics of higher education in the United States, with an emphasis on four-year institutions, although some attention is also given to community colleges. Examines the benefits and costs of higher education; revenue resources, with particular attention to tuition, admissions, financial aid, and endowment policies; expenditure trends, resource allocation, and budgetary practices; and fiscal policies that affect faculty and students. (Offered: Spring (even))

EDU 497. Teaching and Learning in Higher Education and Health Care Settings  
A study of theory-based effective teaching, learning, and assessment practices for use in higher education and health care settings. Stresses teaching, learning, and assessment practices that facilitate meaningful learning. Designed to meet the diverse needs and interests of a broad range of graduate students, teachers, and working professionals interested or currently working in higher education and health care settings. (Offered: Fall)

EDU 498. Literacy Learning as Social Practice  
Prerequisites: (Restrictions: Open to students not matriculated in the teaching and curriculum program only with permission of instructor, space permitting)

Assists students in the construction of a comprehensive theoretical framework for understanding and examining the nature of literacy learning in the 21st century. Examines theories of literacy learning and learning more generally, while also addressing current debates in the field of literacy. Challenges students to rethink their definitions of what counts as literacy and their understanding of how people learn. This course is required by all master’s candidates seeking initial and professional certification and is recommended for doctoral students interested in language and literacy research. The course also develops competencies required by the International Literacy Association (ILA) Standards for Reading Specialist/Literacy Coach through assignments, readings, and class activities. (Offered: Fall, Spring, SummerA)

EDU 499. Integrating Social Studies and Technology  
Prepares secondary social studies teachers to enhance students’ learning opportunities with technology tools, while furthering their understanding of the potential affordances and constraints technology poses for cross-cultural learning, teaching, democratic discourse, and social action. Places teaching candidates in experiential contexts working directly with adolescent learners on projects that involve the generation and dissemination of public knowledge through technology, focusing in turn on how and why teachers might use technology tools to empower learners as active citizens of a global society. (Meets content-pedagogy requirement for professional teaching certification). (Offered: Summer (even)B)
Intended for those preparing for district-level leadership positions, including the superintendency. Focuses on the role of the superintendency and the perspective of that position on the challenges, needs, and opportunities facing school districts. Major emphasis is placed on leading a school district and managing school district operations. (Offered: SummerB)

ED 504. Quantitative Research Methods
Prerequisites: [ED 506, ED 528] (Restrictions: Doctoral students only, or by permission of instructor)
Provides an introduction to the quantitative methods commonly used in education research. Covers basic concepts underlying statistical and quantitative reasoning, including descriptive statistics, probability, statistical inference, analysis of variance, correlation, and bivariate and multivariate regression analysis. Students engage in computer-based analyses of education-related problems using SPSS. Includes conducting a quantitative analysis as a research report. (Offered: Spring, SummerA & B)

EDU 504. Economics of Education
Applies theories and analytical methods from economics to the study of complex educational issues, including the value of education to individuals and society; the link between education and economic growth; school choice and its implications for public schools; teacher supply, demand, and quality; and the benefits and costs associated with investments in various educational programs, such as early childhood education. Aims to introduce students to important economic concepts and to develop students’ ability to critically analyze the arguments and evidence surrounding educational policy options through an economics lens. (Offered: Fall (odd))

ED 505. Advanced Quantitative Research Methods
Prerequisites: [ED 504]
Provides an overview of advanced quantitative methods that are widely used by researchers in educational and social science settings. Offers students an opportunity to understand and use more sophisticated statistical techniques to formulate and test relevant research hypotheses; conduct rigorous data analysis; interpret results; report and present research findings; and evaluate existing quantitative research. Topics covered include: logistic regression, factor analysis, and structural equation modeling. (Offered: Fall)

ED 506. Concepts and Issues in Social Science Research
Prerequisites: (Restrictions: Doctoral students only, or by permission of instructor)
Introduces the beginning doctoral student in education and related disciplines to the issues and processes involved in social science research. Major alternative approaches to designing and conducting research are explored. This course is a required prerequisite for all doctoral research methods courses. It is open only to doctoral students, except for master’s students in human development who are in that program’s “research” track (they must get instructor approval in advance). (Offered: Fall, SummerB)

ED 507. Qualitative Research Methods
Prerequisites: [ED 506] (Restrictions: Doctoral students only, or by permission of instructor)
Introduces doctoral students to qualitative research in education. Offers students an opportunity to explore the theoretical and philosophical foundations of interpretivist inquiry while applying these principles to a research project. Students conduct a research study in which they learn the tools of ethnographic data collection and then analyze these data for the final paper. Course readings and class discussion facilitate students’ understanding of the interpretivist paradigm. (Offered: Spring, SummerB)

EDU 510. Working with Clients’ Defenses: Psychodynamic and other Emotion-Focused Approaches
Prerequisites: [EDU 457 and EDU 460 for MS students]
This elective course is designed to further counselor capacities to work with/bypass clients’ defenses and to work directly with their emotions/core affect. In addition to theoretical content and readings, the course relies heavily on practicing skills from brief/intensive psychodynamic and/or emotion-focused approaches. Practice experiences involve other students in the course. Students participate in both counselor roles and client roles with peers. (Offered: Fall (odd))

ED 511. Introduction to Advanced Academic Literacy
This one-credit course will introduce graduate students to the key role that the research literature plays in knowledge consumption and production at the graduate-level. It will help students identify how to locate useful research relevant to their research areas and to read the literature critically and efficiently. Students will analyze the components of research articles to pinpoint how knowledge claims are made and supported. (Offered: Occasionally)

ED 513. Academic Writing for Educators
Prerequisites: (Restrictions: Doctoral students only)
Provides a workshop setting for doctoral students to develop concrete strategies for identifying research topics, searching and evaluating the research literature, and writing literature reviews, particularly in support of doctoral genres such as research papers, comprehensive examinations, dissertation proposals and dissertations. Helps students locate, analyze, and synthesize research literature related to their individual academic interests, and then produce a lengthy literature review. (Note: may not be used for the writing of comprehensive examinations). (Offered: Fall, Spring, SummerB)
**ED 515. Writing for Scholarly Publication in the Social Sciences**  
Prerequisites: (Restrictions: Doctoral students only)  
Introduces the practices, politics, and conventions of publishing in the social sciences, in particular education, educational linguistics, and psychology. Discusses the range of genres of scholarly publication, but focuses on the practices of academic journals. Guides students through understanding the landscape of journal publishing, including citation indexes and impact factor, choosing a target journal, and guidelines and submission practices. Helps students develop an awareness of their particular issues and concerns about writing for publication. This is not a writing workshop in which students work on a text for submission to a journal, but a course in which to gain the background knowledge to support that step. (Offered: Occasionally)

**EDU 515. Decision Making for Educational Leaders I: Analyzing Problems in Schools and Universities**  
Introduces and examines the process of analyzing problems and making decisions in educational administration. Links current decision theory with contemporary educational problems. Through a series of case studies, considers a variety of decision-making approaches ranging from the classical model of optimizing to normative models of shared decision making. (Offered: Fall)

**ED 516. Designing and Evaluating Professional Development**  
Engages educators, administrators, teacher leaders, curriculum specialists, and professional development providers in examining the issues related to designing and evaluating professional development. Critically examines research on the role professional development plays in promoting change; the characteristics of effective professional development programs; and methods for evaluating professional development programs and materials. Engages students in designing large- and small-scale professional development programs and in implementing and evaluating professional development initiatives. (Offered: SummerB)

**EDU 516. Decision Making for Educational Leaders II: Making Decisions in Schools and Universities**  
Prerequisites: [EDU 515]  
Advances understanding of effective leadership by emphasizing those factors that affect the rational models of decision making in ways that make decision making harder, more complex, and even “irrational.” Draws on literature from psychology, political science, and public choice to help in understanding and improving decision making in educational institutions. (Offered: Spring)

**ED 520. Program Evaluation**  
Prerequisites: [ED 506 for doctoral students, ED 406 or equivalent for other students, ED 504 and ED 507 recommended] (Restrictions: Doctoral students or students in program evaluation certification, or by permission of instructor; no audits)  
Program evaluation continues to grow in importance and is utilized in many fields, including education, criminal justice, science and technology, and health and human services. It is a form of applied research that involves the systematic collection and analysis of data with the purpose of evaluating the design, implementation and/or effectiveness of programs or projects under review. This introduction to program evaluation course is designed to provide an overview of both past and current perspectives on approaches to evaluation, including theory, method and practice. In this course, students critically examine the historical context of program evaluation, major evaluation theories and theorists, and approaches to evaluation. Students have the chance to apply the theories covered in the course through case study analyses. Students gain an understanding of theories, applications and approaches within the context of formal program evaluation and are able to develop a program evaluation design. (Offered: Fall, SummerA)

**ED 521. Advanced Program Evaluation**  
Prerequisites: [ED 520] (Restrictions: Doctoral students or students in program evaluation certification, or by permission of instructor; no audits)  
Program evaluation helps decision makers work with data to assess community needs, launch a new program, follow the progress of an existing program, and/or summarize program outcomes. This second course in program evaluation delves deeper into the various approaches for evaluating educational and community programs. Students gain practical experience through individual and group in and out of class activities that allow them to continue to develop their evaluation skills. By the end of the course, students will have had the opportunity to design a proposal and work on a real program evaluation project. (Offered: Spring)

**EDU 522. Theory and Research in Learning**  
Prerequisites: (Restrictions: Doctoral students only)  
Explores theories of learning to better understand different conceptions of how people learn, the contexts of learning, the mechanisms by which people learn, how learning is externally manifested, and political, ideological, and cultural dimensions of research on learning. Looks at a plethora of theories designed to inform or describe learning (e.g., individual cognitive, socially constructed, reproductive, domain-specific, etc.) through course readings. Provides opportunities for in-depth exploration and critical analysis of learning theories, including historical, cultural, social, and political influences on their development and implementation. Through careful reading, dialogue, writing, and presentation, course participants develop knowledge and skills in critical analysis of learning theories, bridging theory and practice, and linking what they learn to their own practice as educators. (Offered: Fall)
ED 523. Mixed Research Methods  
**Prerequisites:** [ED 506, ED 504, ED 507]  
The strength of a mixed-method approach to educational and psychological research is in its “triangulation” of multiple sources of data. The method provides an opportunity to explore various strategies for combining qualitative and quantitative approaches. This course is designed to introduce doctoral students to the benefits and limitations of mixed methods research and includes: appropriate research problems for application of a mixed methodology, designs for data collection, and integration within the broader field of basic and applied social science research. (Offered: Fall (odd))

EDU 523. Theory and Research in Teaching  
**Prerequisites:** (Restrictions: Doctoral students only)  
Designed to help doctoral students understand the depth and breadth of teaching as a field of study, examining the evolution of and current links between theory and research via four concurrently contested questions about teaching: (1) how is the work of teaching defined; (2) what are the relationships between teaching and the contexts in which it happens; (3) how do teachers learn and change; and (4) how are constructs of “good teaching” generated, evaluated, and advanced? Particular emphases include examining the consequences of different representations of teaching, including various culturally and contextually situated pedagogies, interpreting the constructs of and interactions between teachers’ identities and communities, and assessing the implications of policy and globalization on teaching and teachers. (Offered: Spring)

ED 524. Survey Design (1 credit)  
Covers a range of issues relating to survey design, including choosing the mode of data collection (e.g., phone, online, or mail), identifying the appropriate respondent, developing the questionnaire, and collecting data. Through discussion and experiential exercises, students will acquire practical knowledge and skills relating to survey design. (Offered: Fall, Spring, SummerA)

ED 525. Interview and Focus Group Techniques (1 credit)  
Introduces the methods involved in conducting interviews and focus groups and in managing and interpreting the data they generate. Covers a range of issues from developing protocols and identifying participants to reporting results. (Offered: Fall, Spring, SummerA)

EDU 526. Theory and Research in Curriculum and Change  
**Prerequisites:** (Restrictions: Doctoral students only)  
This is a required course for doctoral students in the teaching and curriculum program in which students will study the breadth of the literature on curriculum and change in education. Curriculum theory and history and the research on educational change and reform will provide an historical context for understanding the field of education broadly defined. (Offered: Fall)

ED 527. Advanced Qualitative Research Methods  
**Prerequisites:** [ED 506, ED 507] (Restrictions: )  
Provides advanced doctoral students with the opportunity to investigate and authentically use qualitative research methods to design their dissertation study. Authentic in this case means that the research project should further the student’s dissertation research. Readings, assignments, and class discussion focus on rigorous qualitative study design. Students must have completed at least one comprehensive exam before receiving instructor permission to enroll. (Offered: Fall)

ED 528. Using Quantitative Data Analysis Software (1 credit)  
**Prerequisites:** [ED 506 (or concurrently)] (Students with experience using software package may contact instructor to schedule an on-site proficiency exam to waive this requirement.) (Restrictions: Students must take this course prior to enrolling in ED 504. Students with experience using the software package may contact the instructor to schedule an on-site proficiency exam to waive this prerequisite.)  
Introduces students to statistical analysis software. Through hands-on opportunities on the computer, students learn how to import and transform quantitative data sets. The course frequently focuses on SPSS software, allowing students the opportunity to modify data files, conduct basic statistical analysis, and create charts and graphs. Occasionally the course will focus on other software (see course title on the schedule for clarification). Open to students at all points in their academic programs. Course does not cover the concepts and mechanics taught in ED 504. (Offered: Fall, Spring, SummerA)

EDU 528. Advanced Qualitative Research Methods for Social Science Research  
**Prerequisites:** ED 506, ED 507  
Focusses on applications of qualitative methods with a primary emphasis on interviews, focus groups, case studies, documents, and open-ended survey responses. This course is conducted as a seminar, using academic readings and research briefs, guest speakers, research studies, and data sets to provide students with the opportunity to engage in rich discussions around designing qualitative research studies, collective and analyzing various types of qualitative data, interpreting qualitative data (particularly when using multiple methods), and writing about and presenting results to diverse audiences. (Offered: Spring)

ED 529. Using Qualitative Data Analysis Software (1 credit)  
**Prerequisites:** [ED 506]  
Introduces students to qualitative analysis software. Through hands-on opportunities on the computer, students learn how to import and code qualitative data (e.g., interview transcripts, speeches, etc.). The course frequently focuses on Qualitative software packages, allowing students the opportunity to code text thematically, conduct basic qualitative analysis, and create coded reports. Occasionally the course will focus on other software (see course title on the schedule for clarification). This course is open to doctoral students at all points in their academic programs. (Offered: Fall, Occasionally)
**ED 531. Case Study Design and Analysis (1 credit)**  
*Prerequisites: [ED 506]*

Introduces students to case study research design and prepares them to use case study methods in their own research. Provides students with the skills needed to analyze articles and books using case study methods and familiarizes them with research design issues, as well as data collection, analysis, and writing strategies. (Offered: Occasionally)

**EDE 531. Globalization, Education and Societies**

As the globe becomes increasingly interconnected, nations are becoming similar in the educational and cultural practices, particularly if they adopt the aims of what Finnish educator Pasi Sahlberg calls the Global Education Reform Network or GERM, modeled after reforms in the United States. However, GERM is often resisted for its negative consequences. In this course, we will place education within the larger context of the differences between nations in terms of the culture and education and seek to understand education’s impact on the economic and political welfare of a county. We will look at specific countries, such as Australia, New Zealand, England, China, Finland and the United States, and regions, such as Latin America and Africa. (Offered: Occasionally)

**ED 532. Action Research Methods (1 credit)**

Action research is a research approach that supports educators who aim to assess and improve their own or others’ educational practices. Therefore, this course is useful for individuals who aim to reflect on their own or others’ practices and then plan, implement, and evaluate their own or others’ practices. (Offered: Fall)

**EDE 532. Dewey, Democracy, and Globalization**

The year 2016 marks the centennial of the publication of John Dewey’s book Democracy and Education, perhaps the most significant book in the history of education not only when it was published but also now. This course aims to help students understand Dewey’s ideas for what they say about education today in a globalized world, including how to think about what and how to teach in a democratic society. Besides reading some of Dewey’s central texts, students also explore the ways in which Dewey has been interpreted and his ideas applied not only in the United States but also across other continents. (Offered: Occasionally)

**ED 533. Research Strategies Series**  
*Prerequisites: (Restrictions: Open to doctoral students only, or by permission of instructor)*

The Research Strategies series was created for students needing to bundle three 1-credit mini-courses on specific research strategies (e.g., ED 525, ED 526, ED 528, ED 529, ED 531, ED 532) into one course (can be spread over a year’s time). NOTE: Students registered for this course must also register for mini-courses as “audits” and contact Warner registrar to waive audit fee. (Offered: Every fall, spring, and summer A & B) (Offered: Fall, Spring, Summer)

**ED 537. Introduction to Social Network Theory, Methods, and Research Applications**  
*Prerequisites: ED506 (or ED406), ED 504*

Social network analysis (SNA) is a set of theories and analytic methods designed to understand relationships among social actors and to foster examination of how these relationships influence individual and group attitudes and behaviors. SNA differs from conventional research approaches because it explicitly addresses the fact that individuals are interdependent actors, who are embedded in a social structure. In fact, SNA considers these relationships and the emergent social structures generated from them as critical to understanding a variety of phenomenon in social settings. Through this course you will learn about key theories underlying social network analysis and become familiar with qualitative and quantitative techniques and approaches to collecting and analyzing social network data at both the individual and organizational level. Network concepts will be defined and applied to topics in small groups, social movements, organizations, and communities. SNA has recently become an emergent tool in educational research, particularly focusing on student-student (peer) networks, teacher networks, higher education student activism, and policy processes at both the K-12 and higher education levels. We will also consider ways that social network theories and methodological approaches have been fruitfully used to examine issues outside of education, e.g., obesity, friendship, racial stereotypes, epidemics, and many other areas. We will focus on important network concepts like diffusion, centrality, brokering, etc. and apply these to educational and non-educational settings. Prerequisites: ED506 (or ED406) and ED504 (or permission of instructor). (Offered: Occasionally)

**ED 540. Program Evaluation Dissertation Proposal Seminar**  
*Prerequisites: [EDE 550 or EDE 551] (Restrictions: Students in the educational leadership accelerated Ed.D. program)*

Provides students with support as they develop their program evaluation dissertation proposal. This course is the first course in a series for students who are writing a thesis involving a program evaluation project that includes ED 540, ED 541, and ED 542. (Offered: SummerA & B)

**ED 541. Program Evaluation Dissertation Seminar I**  
*Prerequisites: [ED 540] (Restrictions: Students in the educational leadership accelerated Ed.D. program)*

Provides students with support as they design and complete their program evaluation dissertation proposal. This course is the second course in a series for students who are writing a thesis involving a program evaluation project that includes ED 540, ED 541, and ED 542. (Offered: Fall)
ED 542. Program Evaluation Dissertation Seminar II
Prerequisites: [ED 541] (Restrictions: Students in the educational leadership accelerated Ed.D. program)

Provides students with support as they develop their program evaluation dissertation proposal. This course is the third course in a series for students who are writing a thesis involving a program evaluation project that includes ED 540, ED 541, and ED 542. (Offered: Spring)

ED 543. Decision Making Dissertation Seminar I
Prerequisites: [ED 546; permission of an instructor required] (Restrictions: Students in the educational leadership accelerated Ed.D. program)

Provides students with support as they design and complete a decision analysis dissertation. This course is the second course in a series for students who are writing a thesis involving a decision making project that includes ED 546, ED 543, and ED 544. (Offered: Fall)

ED 544. Decision Making Dissertation Seminar II
Prerequisites: [ED 543] (Restrictions: Students in the educational leadership accelerated Ed.D. program)

Provides students with support as they design and complete a decision analysis dissertation. This course is the third course in a series for students who are writing a thesis involving a decision making project that includes ED 546, ED 543, and ED 544. (Offered: Spring)

ED 545. Program Evaluation Practicum
Prerequisites: [ED 520, ED 521] (Restrictions: Doctoral students or students in program evaluation certification, or by permission of instructor)

Provides students with a guided independent experience in conducting a program evaluation in a higher education, K-12, or community setting. Students develop an evaluation site and proposal, carrying out the evaluation and submitting an evaluation report as a final practicum project, and work with an evaluation faculty member to develop their practicum experience. (Offered: Fall, Spring, Summer A & B)

ED 545D. Implementing STEM Teaching IV

ED 545E. Implementing STEM Coaching I

ED 546. Decision Making Dissertation Proposal Seminar
Prerequisites: [EDE 550 or EDE 551] (Restrictions: Students in the educational leadership accelerated Ed.D. program)

Provides students with support as they develop their decision analysis dissertation proposal. This course is the first course in a series for students who are writing a dissertation involving a decision making project that includes ED 545, ED 543, and ED 544. (Offered: Summer A & B)

ED 546. Teaching & Learning STEM

ED 547. Teaching & Learning STEM

ED 548. Decision Making Dissertation Proposal Seminar
Prerequisites: [ED 546; permission of an instructor required] (Restrictions: Students in the educational leadership accelerated Ed.D. program)

Provides students with support as they develop their dissertation proposal. This course is the third course in a series for students who are writing a dissertation involving a decision analysis dissertation. This course is the second course in a series for students who are writing a thesis involving a decision making project that includes ED 545, ED 543, and ED 544. (Offered: Spring)

ED 549. Decision Making Dissertation Seminar I
Prerequisites: [ED 543] (Restrictions: Students in the educational leadership accelerated Ed.D. program)

Provides students with support as they design and complete a decision analysis dissertation. This course is the second course in a series for students who are writing a thesis involving a decision making project that includes ED 545, ED 543, and ED 544. (Offered: Fall)

ED 549D. Implementing STEM Teaching IV

ED 549E. Implementing STEM Coaching I

ED 550. Comprehensive Exam Research: K12 Educational Leadership EdD
Prerequisites: Completion of EdD Coursework

Provides evidence that the candidate has mastered the knowledge needed to be an educational leader by allowing students to apply concepts, theories, and frameworks learned in their coursework to realistic scenarios. Successful completion of the Qualifying Case Analysis is required before students can advance to the proposal writing stage of a field-based dissertation (e.g., Program Evaluation or Decision Analysis). (Offered: Occasionally)

ED 551. Comprehensive Exam Research: Higher Education EdD
Prerequisites: Completion of Ed.D. coursework (Restrictions: Students in the higher education Ed.D. program)

Provides evidence that Ed.D. candidates have mastered the knowledge needed to work in higher education by allowing students to apply concepts, theories, and frameworks learned in their coursework. Successful completion of the Comprehensive Exam is required before students can advance to the proposal writing stage of their dissertation. (Offered: Spring)

ED 552. Comprehensive Exam Research: Educational Leadership, K12 Administration PhD
(Offered: Fall, Spring, Summer A & B)

EDU 552. Counselor Education
Prerequisites: (Restrictions: Enrollment limited to matriculated doctoral degree candidates in the counseling program, or by permission of instructor)

Introduces the professional field of counselor education and an understanding of its theory, research, and practices. Includes the history, roles, standards, ethics, professional organizations, and publications of the counselor education field. Also includes instructional theory and opportunities to observe and practice counselor education instructional skills. (Offered: Fall (even))

ED 553. Teaching & Curriculum Dissertation Proposal Seminar
Prerequisites: (Restrictions: For accelerated Ed.D. students only)

Provides students in the Accelerated Ed.D. program with support for writing their action research dissertation proposal. Drawing on previous coursework, the comprehensive exam, and a pilot project, students are supported to develop a defensible dissertation proposal. (Offered: Summer A & B)
**EDE 553. Comprehensive Exam Research: Higher Education PhD**
(Offered: Fall, Spring, Summer A & B)

**EDU 553. Counselor Supervision**
Prerequisites: (Restrictions: Enrollment limited to matriculated doctoral degree candidates in the counseling program, or by permission of instructor)

Provides students with an understanding of theory, research, and practices in counselor supervision. Includes history, standards, ethics, professional organizations, and publications in counselor supervision. Also includes opportunities to observe and practice counseling supervision. (Offered: Spring)

**EDU 554. Action Research Dissertation Seminar I**
Prerequisites: [ED 553] (Restrictions: For accelerated Ed.D. students only)

Provides a supported research experience for students in the accelerated Ed.D. program to conduct their action research dissertation projects. Students and faculty support one another in carrying out an action research dissertation, including analyzing data as it is collected, reformulating questions, and describing tentative findings. (Offered: Fall)

**EDE 554. Comprehensive Exam Research: Educational Policy & Theory PhD**
(Offered: Fall, Spring, Summer A & B)

**EDU 554. Advanced Theory, Research, and Practice in Group Work**
Prerequisites: (Restrictions: Enrollment limited to matriculated doctoral degree candidates in the counseling program, or by permission of instructor)

Deepens students’ theoretical and practical understanding of group facilitation and group counseling. Students are required to integrate their theoretical study with personal and practical experiences in the classroom and the field. (Offered: Spring (odd))

**EDU 555. Action Research Dissertation Seminar II**
Prerequisites: [ED 554] (Restrictions: For accelerated Ed.D. students only)

Assists students in presenting their findings, including writing the dissertation and presenting their research through other media such as video. Students present to their colleagues in the class in addition to preparing for the final dissertation defense. (Offered: Spring)

**EDE 555. Comprehensive Exam Research: Counseling & Human Development PhD**
Prerequisites: (Restrictions: PhD students only)
(Offered: Fall, Spring, Summer A & B)

**EDU 555. Advanced Counseling Theory, Research, and Practice**
Prerequisites: (Restrictions: Enrollment limited to matriculated doctoral degree candidates in the counseling program, or by permission of instructor)

Aims to deepen students’ knowledge of existing counseling traditions; introduce new counseling theories and approaches; examine theories from various critical perspectives; understand counseling outcome research; and develop students’ own integrated theory and practice of counseling. Students are required to complete an in-depth analysis of a theory germane to their particular interest area. (Offered: Spring (even))

**EDE 556. Comprehensive Exam Research: Counseling & Human Development EdD**
(Offered: Fall, Spring, Summer A & B)

**EDE 557. Comprehensive Exam Research: Teaching & Curriculum PhD**
Offered: Fall, Spring, Summer A & B)

**EDU 557. Selected Theories of Human Development**
Prerequisites: [ED 429 or equivalent] (Restrictions: Students may take this course multiple times)

Each semester it is offered, this course showcases a different topic taught by a faculty member with an expertise reflected in the subject matter chosen for that particular semester. Recent topics covered include: Theories of Social and Emotional Development; Mind in Sociocultural Context; and Issues in Developmental Differences. (Offered: Occasionally)

**EDE 558. Comprehensive Exam Research: Teaching & Curriculum EdD**
(Offered: Fall, Spring, Summer A & B)

**EDE 560. Portfolio Review: Ed Leadership**

The purpose of the portfolio evaluation is to provide you with feedback on your progress. Specifically, the evaluation allows the faculty to assess at an early point in your program (1) the appropriateness of your Program of Study, (2) the quality of your writing, (3) your course grades, and (4) anticipated scholarly focus. (Offered: Fall)

**EDU 560. Research in Cognitive Development**

Provides a critical overview of theories and research in cognitive development, from birth through adolescence. Explores the contextualized (ecological) perspective and what it might tell us about human thought; the origins of knowledge; ecological cognition; culture and cognition; and the “self.” (Offered: Spring (even))
**ED 561A. Counseling & Human Development Doctoral Cohort Seminar 1A**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Designed to support students enrolled in the first two years of the accelerated Ed.D. programs in counseling and human development. Focuses on the challenges in developing a dissertation topic, creating the environment at work to support the dissertation topic, and examining the existing scholarly literature related to the potential dissertation topic. Meetings are held as needed by students after the first required meeting each semester, and will meet frequently in the second year. (Offered: SummerA & B)

**ED 561B. Counseling & Human Development Doctoral Cohort Seminar 1B**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Designed to support students enrolled in the first two years of the accelerated Ed.D. programs in counseling and human development. Focuses on the challenges in developing a dissertation topic, creating the environment at work to support the dissertation topic, and examining the existing scholarly literature related to the potential dissertation topic. Meetings are held as needed by students after the first required meeting each semester, and will meet frequently in the second year. (Offered: Fall)

**ED 561C. Counseling & Human Development Doctoral Cohort Seminar 1C**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Designed to support students enrolled in the first two years of the accelerated Ed.D. programs in counseling and human development. Focuses on the challenges in developing a dissertation topic, creating the environment at work to support the dissertation topic, and examining the existing scholarly literature related to the potential dissertation topic. Meetings are held as needed by students after the first required meeting each semester, and will meet frequently in the second year. (Offered: Spring)

**EDE 561. Portfolio Review: Teaching & Curriculum**

The purpose of the portfolio evaluation is to provide feedback on your progress. Specifically, the evaluation allows the faculty to assess at an early point in the student’s program (1) the appropriateness of your Program of Study, (2) the quality of your writing, (3) your course grades, and (4) anticipated scholarly focus. The evaluation allows the faculty to assess at an early point in the student’s program (1) the appropriateness of your Program of Study, (2) the quality of your writing, (3) your course grades, and (4) anticipated scholarly focus. (Offered: Spring)

**ED 562A. Counseling & Human Development Doctoral Cohort Seminar 2A**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Designed to support students enrolled in the first two years of the accelerated Ed.D. programs in counseling and human development. Focuses on the challenges in developing a dissertation topic, creating the environment at work to support the dissertation topic, and examining the existing scholarly literature related to the potential dissertation topic. Meetings are held as needed by students after the first required meeting each semester, and will meet frequently in the second year. (Offered: SummerA & B)

**ED 562B. Counseling & Human Development Doctoral Cohort Seminar 2B**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Designed to support students enrolled in the first two years of the accelerated Ed.D. programs in counseling and human development. Focuses on the challenges in developing a dissertation topic, creating the environment at work to support the dissertation topic, and examining the existing scholarly literature related to the potential dissertation topic. Meetings are held as needed by students after the first required meeting each semester, and will meet frequently in the second year. (Offered: Fall)

**ED 562C. Counseling & Human Development Doctoral Cohort Seminar 2C**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Designed to support students enrolled in the first two years of the accelerated Ed.D. programs in counseling and human development. Focuses on the challenges in developing a dissertation topic, creating the environment at work to support the dissertation topic, and examining the existing scholarly literature related to the potential dissertation topic. Meetings are held as needed by students after the first required meeting each semester, and will meet frequently in the second year. (Offered: Fall)

**EDE 562. Portfolio Review: Counseling & Human Development**

The purpose of the portfolio evaluation is to provide feedback on your progress. Specifically, the evaluation allows the faculty to assess at an early point in the student’s program (1) the appropriateness of the Program of Study, (2) the quality of the student’s writing, (3) course grades, and (4) anticipated scholarly focus. (Offered: Fall)

**ED 563. Counseling & Human Development Dissertation Proposal Seminar**  
Prerequisites: (Restrictions: Counseling and human development accelerated Ed.D. students only)

Provides support to accelerated Ed.D students as they develop and write the dissertation proposal in preparation for the oral defense. Support in submitting the forms for the Research Subjects Review Board is provided. (Offered: Spring, SummerA & B)
EDU 563. Advocacy, Consulting, and Systems Change as Counseling and Human Development Practice  
Prerequisites: (Restrictions: Enrollment limited to matriculated doctoral degree candidates in the counseling and human development programs, or by permission of instructor)  
Situated counselors, clients, schools and community agencies in relation to relevant social systemic forces. Explores systems theory and models of intervention that are facilitated through advocacy, consultation, and challenge to existing social systems. This approach to human development is directed toward understanding the design and implementation of practices facilitating psychological competence and empowerment, preventing disorder, and promoting social action and change. Includes basic principles of program evaluation. (Offered: Fall (odd))

EDU 564. Counseling & Human Development Dissertation Seminar I  
Prerequisites: [ED 563] (Restrictions: Counseling and human development accelerated Ed.D. students only)  
Provides ongoing support to accelerated Ed.D students as they work through the various aspects of collecting, analyzing, and interpreting dissertation data. (Offered: Fall)

EDU 565. Research in Life Course Studies  
Prerequisites: (Restrictions: Enrollment limited to matriculated Warner doctoral candidates in the counseling and human development programs, or by permission of instructor)  
Examines how research on the heterogeneity or variability of human development can take into account the macro- and micro-systemic contexts, sociohistorical and geographical location, the timing of life transitions, social ties, and human agency. Particular attention is given to social, cultural, and historical factors in shaping individual developmental trajectories from childhood through late life. Critical evaluation of current life course research is emphasized. Students focus on applying the life course perspective to specific research areas. (Offered: Fall (even))

EDU 566. Counseling and Human Development Ph.D. Dissertation Proposal Seminar  
This course is designed to scaffold students’ dissertation proposal writing experiences. Introduces doctoral students to the key elements of a dissertation proposal and provides chapter-by-chapter support for negotiating the proposal’s content. Students share their own writing process with the class and are expected to actively participate in discussions that address roadblocks encountered by classmates. The course schedule budgets the timing of assignments so that students will have a complete proposal manuscript by the end of the course. Completion of two of the three comprehensive examination questions, or permission of the instructor, is required. (Offered: Spring)

EDU 568. Conducting Research Using Secondary Data  
Prerequisites: ED506, ED504, and ED506  
Secondary data analysis describes an approach to research in which investigators ask empirical questions using a data set created by someone else for another primary purpose. Often such data sets are available from large studies that would not be feasible to conduct independently. Use of secondary data brings unique opportunities and challenges. The course provides doctoral students with the knowledge and skills to use high-quality secondary data analysis in their research agendas. The course emphasizes application, with students completing an empirical research paper that could lead to a conference presentation and/or publishable paper. Topics include: finding and evaluating sources of secondary data; data cleaning, management, and preparation; handling missing data; and sampling design and weights. Students are supported to become an expert in at least one secondary data set and to complete an empirical research project that could lead to a paper of publishable quality. (Offered: Spring (even))

EDU 569. Studying Human Development, Counseling, and Education in Context: Advances in Design and Method  
Prerequisites: [ED 506, ED 504]  
Focuses on understanding, evaluating and designing research that uses complex longitudinal designs and advanced quantitative methods in order to take into account both individual and group change over time, contextual influences on development that change over time, and variation across multiple data collection sites. Covers the integration of quantitative research with community-based participatory research principles. The focus of the class is on matching research questions to designs and methods of analysis. It is not designed to teach students to perform...
statistical analyses directly; however, students will emerge with the ability to interpret advanced statistics commonly encountered in human development articles and conference presentations. (Offered: Spring (even))

EDU 571. Advanced Doctoral Seminar on Theory and Research in Teacher Education
Prerequisites: (Restrictions: Doctoral students only or by permission of instructor)
Investigates historical and contemporary issues around the design and implementation of pre-service and in-service teacher education, primarily in the United States. Addresses the challenges of contemporary teacher education to prepare teachers to teach in an increasingly diverse and globalized world by exploring what policy and research say about what teachers need to know, the kinds of instructional practices in which they need to be proficient, and how best to support them. Explores questions, such as: (1) What should be the balance in pre-service teacher education between (a) developing candidates’ awareness of student diversity along multiple dimensions and (b) developing candidates’ content knowledge and technical aspects of classroom management and lesson planning; and (2) In terms of in-service teacher learning, how can school organizations support teachers to take up the kinds of challenging instructional practices that lead to student learning and disposition to learn? Explores multiple programmatic pathways and pedagogies, their impact on pre-service teachers’ knowledge and beliefs, and their relationships to educational policy. In terms of in-service teacher education, the course explores different modes of professional development, from teacher inquiry within classrooms to school-community partnerships, and the implications of professional development for teachers’ career trajectories and their work within a climate of high-stakes, test-based accountability. (Offered: Occasionally, Spring (odd))

EDU 572. Designing Intervention Research in Applied Settings
Prerequisites: ED506, ED504
Addresses the design of intervention research—research that considers the impact of a curriculum or program in authentic, applied contexts. The course is useful for students who plan to design and conduct their own intervention research or work in applied settings where such research could take place. Topics include: designing to enable causal inferences, experimental and quasi-experimental designs, measuring and supporting fidelity of implementation, and practical considerations like building partnerships and communicating findings. (Offered: Spring)

EDU 572. Development of Selves
Offers an interdisciplinary treatment of the development of self and identity, considering psychological, sociological, anthropological, and historical theories of selfhood and its development. Emphasis is placed on understanding selfhood in relation to the sociocultural contexts of development. (Offered: Spring (even), Spring (odd))

EDU 576. Contemporary Issues in Higher Education
Explores contemporary policy issues in higher education. The purpose of this course is threefold: to develop an understanding of key policy issues at the international, national, state, and institutional levels; to conduct policy analysis of national issues in American higher education; and to develop an integrated view of policy and practice for practitioners working in higher education. (Offered: Fall)

EDU 580. Foundations of Health Professions Education
A foundational study of the historical, scientific, social, and political roots of health professions education, educational theory, and the continuum of this education. Provides the contextual framework for education in the health professions and emphasizes the historical and sociological theory of the evolution of this education. Critically examines the roles and responsibilities in the assessment and certification of graduates, as well as discusses the framework for accreditation and licensing of health care professionals. Current program assessment methods and tools are reviewed, as well as ethics and responsibilities of education leaders in different roles. (Offered: Fall)

EDU 581. Discourse Analysis in Education Research
Prerequisites: [ED 506, ED 507] (Restrictions: Permission of instructor required)
Introduces students to discourse analysis, which has become a key analytic lens in educational research, as a research methodology and analytic framework for the examination of language in use. Provides students with opportunities to discuss central theoretical issues in discourse analysis and to work with language data to develop students’ analytic skills and to receive critical feedback on their work. Introduces students to discourse analysis from the following theoretical positions: linguistic anthropology, critical discourse analysis, and sociolinguistics. The course is intended for advanced doctoral students who have taken introductory research methods courses and those interested in learning about discourse analysis to advance their own research. It may be used to fulfill the advanced qualitative research methods course requirement for PhD students, and counts as research credit in the program of study. Students should discuss this option with their advisor. (Offered: Spring)

EDU 581. Clinical Teaching in Health Care Professions Education: Teaching and Instructional Methods
Prerequisites: [EDU 497]
Presents traditional and innovative methods used in clinical teaching to enhance student and practitioner knowledge, skills, and attitudes, and critically examines the theories behind different teaching methodologies. Discusses current and potential future uses of technology in active learning strategies in the clinical environment. Also explores ethical and patient safety issues. (NOTE: this class is also part of the School of Nursing’s MNE [Master’s in Nursing Education] programs, but it is then a 4-credit hour class because it includes an additional nursing student teaching practicum.) (Offered: Spring)
ED 582. Critical Literacy
Prerequisites: [EDU 498, or by permission of instructor]
Consider the origins and contemporary applications of the concept of critical literacy. Develops an understanding of literacy as a critical social practice that may be used to enact social change. Issues explored include: the politics, ideology and social context of literacy; multiple literacies; the role of literacy in production of power; critiques of critical pedagogy/literacy. Surveys how critical literacy has been implemented in a range of contexts, including media and digital literacies, and covers critical literacy responses to the growing dominance of the English language in an era of globalization. (Offered: Occasionally)

ED 588. Doctoral Seminar: Topics in Teaching & Curriculum
Prerequisites: (Restrictions: Restricted to advanced doctoral students who are well along in their programs and have completed at least ED 506 or permission on instructor)
This doctoral seminar focuses on a different topic in research each time it is offered. (Offered: Spring)

ED 591. Independent Study in Education --Doctoral Level (variable credits)
Prerequisites: (Restrictions: Doctoral students only, or by permission of instructor)
This option is the one most commonly used by doctoral students who are interested in studying a particular topic through independent readings and other activities. The specific nature of the study and criteria for evaluation need to be articulated in writing within the first two weeks of the semester by using a specific Independent Study Form that requires the signature of the faculty member supervising the study, as well as the program chair and associate dean of graduate studies. (Offered: Fall, Spring, Summer A & B)

ED 592. Field Study in Education -- Doctoral Level (variable credits)
Prerequisites: (Restrictions: Doctoral students only, or by permission of instructor)
This option can be used by doctoral students who are interested in engaging in a supervised project or field experience relevant to their program. (Offered: Fall, Spring, Summer A & B)

ED 593B. EdD Research Abroad
Prerequisites: (Restrictions: Must have completed Comprehensive Exams)
EdD students conducting research abroad should register for this research category. (Offered: Fall, Spring)

ED 593. Ed.D. Research (Dissertation) (variable credits)
Prerequisites: (Restrictions: Doctoral students who have passed their comprehensive exam)
Ed.D students working on their dissertation should register for this course. Please note: Registration in this course is limited to students who have completed their doctoral comprehensive exam. (Offered: Fall, Spring, Summer A & B)

ED 594. Research at East
Our EPO partnership with East High School is an exciting opportunity to take what researchers and educators know about urban education to a high-needs school. It is crucial that we document this partnership with rigorous research, but that we do not position East as a research lab. This course provides doctoral students structured support to explore research at East that meets the following criteria agreed upon by the East community: Research must benefit the mission of the school; Relevance to practice must be an explicit criteria; Research must be useful to the East community; Proposals must be explicit about how this community will benefit (not just researcher benefit) and must show how the research will advance the needs of the school without overburdening East and without being intrusive; and Dissemination of results needs to include the East community (teachers, administrators, students, family members). (Offered: Occasionally)

ED 595B. PhD Research Abroad
Prerequisites: (Restrictions: Must have completed Comprehensive Exam.)
PhD students conducting research abroad should register for this research category. (Offered: Fall, Spring)

ED 595. Ph.D. Research (Dissertation) (variable credits)
Prerequisites: (Restrictions: Doctoral students who have passed their comprehensive exam)
Ph.D. students working on their dissertation should register for this course. Please note: Registration in this course is limited to students who have completed their doctoral comprehensive exam. (Offered: Fall, Spring, Summer A & B)

ED 596. Research Apprenticeship -- Doctoral Level (variable credits)
Prerequisites: (Restrictions: Doctoral students only, or by permission of instructor)
This course, required for Ph.D. students, is designed to apprentice novice scholars in a variety of research practices. Students participate in an existing research project directed by a Wärner faculty member (with permission and under the supervision of that faculty member). The research apprenticeship is a requirement for all Ph.D. students, but is open to other Warner students as well. (Offered: Fall, Spring, Summer A & B)

ED 895. Continuation of Master’s Enrollment
A zero-credit hour registration status, carrying a flat fee, and placing student at X-time status; maintains continuous enrollment. Does not qualify student to procure or defer student loans. (Offered: Fall, Spring)

ED 898. Master’s Thesis: Half-Time
Half-time registration status carrying a flat fee and allowing student to procure and/or defer student loans; can be taken as a stand-alone registration while student completes his or her thesis, portfolio, Master’s Essay, or other culminating activity -or- in
combination with other classes to bring student to half-time status (if used in conjunction with other credit-bearing registration, fee is waived). This and similar registration statuses can be used up to two (2) times as a stand-alone registration or four (4) times in combination with other credit-bearing registrations before a student graduates. (Offered: Fall, Spring, Summer A & B)

**ED 898B. Master’s Thesis—International**

Full-time registration status created for international students studying abroad and carrying a flat fee. Can be taken as a stand-alone registration while student completes his or her thesis, portfolio, Master’s Essay, or other culminating activity -or- in combination with other credit-bearing registration to bring student to full-time status (if used in conjunction with other credit-bearing registrations, fee is waived). This and similar registration statuses can be used up to a maximum of four (4) times in combination with other credit-bearing registrations before a student graduates. (Offered: Fall, Spring)

**ED 899. Master’s Thesis: Full-Time**

Full-time registration status carrying a flat fee, allowing student to procure and/or defer student loans, and requiring student to pay Mandatory Health Fee; can be taken as a stand-alone registration while student completes his or her thesis, portfolio, Master’s Essay, or other culminating activity -or- in combination with other classes to bring student to full-time status (if used in conjunction with other credit-bearing registration, fee is waived). This and similar registration statuses can be used up to a maximum of two (2) times as a stand-alone registration or four (4) times in combination with other credit-bearing registrations before a student graduates. (Offered: Fall, Spring, Summer)

**ED 985. Leave of Absence**

A personal, professional or medical leave of absence requiring 1) registration online and 2) completion of application available on Warner’s website and 3) payment of a nominal fee; student may utilize this registration status twice for personal and professional leaves and indefinitely for medical leaves. (Offered: Fall, Spring, Summer)

**ED 995. Continuation of Doctoral Enrollment**

A zero-credit hour registration status, carrying a flat fee, and placing doctoral candidate at X-time status; maintains continuous enrollment. Does not qualify student to procure or defer student loans. (Offered: Fall, Spring)

**ED 998. Doc Dissertation: Half-Time**

Half-time registration status carrying a flat fee and allowing student to procure and/or defer student loans; can be taken as a stand-alone registration while doctoral candidate completes his or her dissertation -or- in combination with other classes to bring student to half-time status (if used in conjunction with other credit-bearing registration, fee is waived). This and similar registration statuses can be used up to four (4) times as a stand-alone registration or eight (8) times in combination with other credit-bearing registrations before a student graduates. (Offered: Fall, Spring, Summer A & B)

**ED 999B. Doc Dissertation--International**

Full-time registration status created for international students studying abroad and carrying a flat fee. Can be taken as a stand-alone registration while doctoral candidate completes his or her dissertation -or- in combination with credit bearing registration to bring him or her to full-time status (if used in conjunction with other credit-bearing registration, fee is waived). (Offered: Fall, Spring)

**ED 999. Doctoral Dissertation: Full-Time**

Full-time registration status carrying a flat fee, allowing student to procure and/or defer student loans, and requiring student to pay Mandatory Health Fee; can be taken as a stand-alone registration while doctoral candidate completes his or her dissertation -or- in combination with other credit-bearing registration to bring him or her to full-time status (if used in conjunction with other credit-bearing registration, fee is waived). This and similar registration statuses can be used up to a maximum of four (4) times as a stand-alone registration or eight (8) times in combination with other credit-bearing registrations before a student graduates. (Offered: Fall, Spring, Summer)

**ED 404. Field Experiences in Elementary Schools**

Prerequisites: [EDU498; *EDU427] (Restrictions: Pre-service teachers must take methods course concurrently.)

(Offered: Fall)

**ED 405. Field Experiences in Inclusive Elementary School Settings**

Prerequisites: [EDU498; *EDU427; or ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)

(Offered: Fall)

**ED 406. Student Teaching in Elementary Schools A**

Prerequisites: [*EDF404 or *EDF405] (Restrictions: Pre-service teachers must take methods course concurrently.)

(Offered: Fall)

**ED 407. Student Teaching in Inclusive Elementary School Settings A**

Prerequisites: [*EDF405 or ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)

(Offered: Fall)

**ED 408. Student Teaching in Elementary Schools B**

Prerequisites: [EDF406 or EDF407] (Restrictions: Pre-service teachers must take methods course concurrently.)

(Offered: Spring)

**ED 409. Student Teaching in Inclusive Elementary School Settings B**

Prerequisites: [EDF406 OR EDF407] (Restrictions: Pre-service teachers must take methods course concurrently.)

(Offered: Spring)
EDF 410E. Field Experiences in Middle Childhood (English)
Prerequisites: [*EDU431] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 410F. Field Experiences in Middle Childhood (Foreign Languages + Latin)
Prerequisites: [*EDU435] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 410H. Field Experiences in Middle Childhood (Social Studies)
Prerequisites: [*EDU432] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 410M. Field Experiences in Middle Childhood (Math)
Prerequisites: [*EDU436] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 410S. Field Experiences in Middle Childhood (Science)
Prerequisites: [*EDU434] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 411E. Field Experiences in Inclusive Middle Childhood Settings (English)
Prerequisites: [*EDU431; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 411F. Field Experiences in Inclusive Middle Childhood Settings (Foreign Languages + Latin)
Prerequisites: [*EDU435; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 411H. Field Experiences in Inclusive Middle Childhood Settings (Social Studies)
Prerequisites: [*EDU452; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 411M. Field Experiences in Inclusive Middle Childhood Settings (Math)
Prerequisites: [*EDU436; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 411S. Field Experiences in Inclusive Middle Childhood Settings (Science)
Prerequisites: [*EDU434; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 416E. Field Experiences in Secondary Schools (English)
Prerequisites: [*EDU431] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 416F. Field Experiences in Secondary Schools (Foreign Languages + Latin)
Prerequisites: [*EDU435] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 416H. Field Experiences in Secondary Schools (Social Studies)
Prerequisites: [*EDU432] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 416M. Field Experiences in Secondary Schools (Math)
Prerequisites: [*EDU436] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 416S. Field Experiences in Secondary Schools (Science)
Prerequisites: [*EDU434] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 417D. Field Experiences in Inclusive Secondary School Settings (generalist)
Prerequisites: [ED 451; ED447] (Restrictions: Candidates enrolled in the Inclusion program.)
(Offered: Fall)

EDF 417E. Field Experiences in Inclusive Secondary School Settings (English)
Prerequisites: [*EDU431; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 417F. Field Experiences in Inclusive Secondary School Settings (Foreign Languages + Latin)
Prerequisites: [*EDU435; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)
EDF 417H. Field Experiences in Inclusive Secondary School Settings (Social Studies)
Prerequisites: [*EDU432; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 417M. Field Experiences in Inclusive Secondary School Settings (Math)
Prerequisites: [*EDU436; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 417S. Field Experiences in Inclusive Secondary School Settings (Science)
Prerequisites: [*EDU434; *ED 447] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 418E. Student Teaching in Secondary Schools A (English)
Prerequisites: [EDF416E or EDF417E; *EDU443] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 418F. Student Teaching in Secondary Schools A (Foreign Languages & Latin)
Prerequisites: [EDF416F or EDF417F; *EDU463] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 418H. Student Teaching in Secondary Schools A (Social Studies)
Prerequisites: [EDF416H or EDF417H; *EDU462] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 418M. Student Teaching in Secondary Schools A (Math)
Prerequisites: [EDF416M or EDF417M; *EDU444] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 418S. Student Teaching in Secondary Schools A (Science)
Prerequisites: [EDF416S or EDF417S; *EDU448] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 419D. Student Teaching in Inclusive Secondary School Settings A (generalist)
Prerequisites: [EDF417D] (Restrictions: Candidates enrolled in the Inclusion program.)
(Offered: Spring)

EDF 419E. Student Teaching in Inclusive Secondary School Settings A (English)
Prerequisites: [EDF417E; *EDU443] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 419F. Student Teaching in Inclusive Secondary School Settings A (Foreign Languages & Latin)
Prerequisites: [EDF417F; *EDU463] (Restrictions: Pre-service teachers taking EDU463 only)
(Offered: Spring)

EDF 419H. Student Teaching in Inclusive Secondary School Settings A (Social Studies)
Prerequisites: [EDF417H; *EDU462] (Restrictions: Pre-service teachers taking EDU462 only)
(Offered: Spring)

EDF 419M. Student Teaching in Inclusive Secondary School Settings A (Math)
Prerequisites: [EDF417M; *EDU444] (Restrictions: Pre-service teachers taking EDU444 only)
(Offered: Spring)

EDF 419S. Student Teaching in Inclusive Secondary School Settings A (Science)
Prerequisites: [EDF417S; *EDU448] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 420E. Student Teaching in Secondary Schools B (English)
Prerequisites: [EDF418E or EDF419E; *EDU443] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 420F. Student Teaching in Secondary Schools B (Foreign Languages & Latin)
Prerequisites: [EDF418F or EDF419F; *EDU463] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 420H. Student Teaching in Secondary Schools B (Social Studies)
Prerequisites: [EDF418H or EDF419H; *EDU462] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 420M. Student Teaching in Secondary Schools B (Math)
Prerequisites: [EDF418M or EDF419M; *EDU444] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)
EDF 420S. Student Teaching in Secondary Schools B (Science)
Prerequisites: [EDF418S or EDF419S; *EDU448] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 421D. Student Teaching in Inclusive Secondary School Settings B (generalist)
Prerequisites: [EDF419D] (Restrictions: Candidates enrolled in the Inclusion program.)
(Offered: Fall, Spring)

EDF 421E. Student Teaching in Inclusive Secondary School Settings B (English)
Prerequisites: [EDF419E; *EDU443] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 421F. Student Teaching in Inclusive Secondary School Settings B (Foreign Languages & Latin)
Prerequisites: [EDF419F; *EDU463] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 421H. Student Teaching in Inclusive Secondary School Settings B (Social Studies)
Prerequisites: [EDF419H; *EDU462] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 421M. Student Teaching in Inclusive Secondary School Settings B (Math)
Prerequisites: [EDF419M; *EDU444] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 421S. Student Teaching in Secondary Schools B (Science)
Prerequisites: [EDF418S or EDF419S; *EDU448] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 426B. Field Experiences in ESOL for Current Teachers
Prerequisites: [*EDU435] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 426. Field Experiences in ESOL
Prerequisites: [*EDU435] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall)

EDF 427. Field Experiences in ESOL in Inclusive School Settings

EDF 428. Student Teaching in ESOL in Elementary Schools
Prerequisites: [EDF426; *EDU463] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 429. Student Teaching in ESOL in Inclusive School Settings A

EDF 430. Student Teaching in ESOL in Secondary Schools
Prerequisites: [EDF426; *EDU463] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Spring)

EDF 431. Field Experiences in EFL
(Offered: Fall, Spring, Summer)

EDF 432. Student Teaching in ESOL
Prerequisites: [EDF426; *EDU463] (Restrictions: Pre-service teachers must take methods course concurrently.)
(Offered: Fall, Spring)

EDF 433. Student Teaching in ESOL in Inclusive School Settings B

EDF 440. Field Experiences with Children 0-3
Prerequisites: [*ED 408 concurrently] (Restrictions: Candidates enrolled in the Early Childhood program.)
(Offered: SummerA & B)

EDF 441. Field Experiences with Children 0-3 in Inclusive Settings
Prerequisites: [*ED 408 or *EDU476] (Restrictions: Candidates enrolled in the Early Childhood program.)
(Offered: SummerA & B)

EDF 442. Student Teaching with Preschool Children
Prerequisites: [*ED 407] (Restrictions: Candidates enrolled in the Early Childhood program.)
(Offered: Spring)

EDF 443. Student Teaching with Preschool Children in Inclusive Settings
Prerequisites: [*ED 407 or *EDU475; **ED 403 or *EDU475] (Restrictions: Candidates enrolled in the Early Childhood program.)
(Offered: Spring)
EDF 444. Field Experiences in American Higher Education (variable credits)  
Prerequisites: (Restrictions: Restricted to matriculated international students)  
Provides international students an opportunity to meet and discuss various topics and ideas originating in students' coursework. Offers support and clarity to the first-year experience of international students. Extends and elaborates on topics covered in EDU 414, and visits to local schools, other Warner classes, and local sociocultural settings are offered to elucidate the American institutions studied by Warner students. This is an optional extension offered to EDU 414 participants. (Offered: Fall, Spring)

EDF 445. Field Experiences with Students with Significant Disabilities  
Prerequisites: [Needs to be taken concurrently with EDE445]  
(Restrictions: Candidates enrolled in the significant disabilities program)  
(Offered: Spring)

EDF 446. Inclusion Adolescence Student Teaching Seminar A  
Prerequisites: (Restrictions: Candidates enrolled in the Inclusion program.)  
(Offered: Fall)

EDF 447. Inclusion Adolescence Student Teaching Seminar B  
Prerequisites: (Restrictions: Candidates enrolled in the Inclusion program.)  
(Offered: Spring)

EDF 448. Field Experience in Academic Program  
Prerequisites: (Restrictions: Restricted to matriculated international students.)  
Curricular Practical Training (CPT) is a valuable part of a student's curriculum that provides a paid or unpaid experience their field of study. International students may apply for CPT after they have completed 2 semesters. The CPT will provide international students an opportunity to meet and discuss various topics and ideas originating in students' coursework. (Offered: Fall, Spring, Summer, SummerA, SummerB)

EDF 450. Practicum in Counseling  
Prerequisites: [EDU 450, EDE 449, EDU 457, EDU 460 or concurrently]  
(Restrictions: Enrollment limited to matriculated master's degree candidates in the school counseling or community mental health program.)  
This introductory onsite practicum experience in a school or community setting develops and improves counseling skills with clients and groups and observes the action of social systems in a real-world environment. Students work at the site, record counseling sessions, receive individual and group supervision, and attend a weekly university class. Practicum in counseling is a prerequisite to all other master's-level internships. (Offered: Spring)

EDF 451. Supervised Internship in School Counseling I  
Prerequisites: [EDF450]  
(Restrictions: Matriculated school counseling students only)  
The first semester of a two-semester field-based experience in a school setting, the school counseling internship includes work at the internship site, individual and group supervision, and attendance at weekly university seminars. Seminar topics vary and include: working with diverse populations, handling crises that may arise during the internship, working with parents and teachers, and other topics that interns may wish to discuss. Taken in the last year of a student's program. (Offered: Fall)

EDF 452. Supervised Internship in School Counseling II  
Prerequisites: [EDF451]  
(Restrictions: Matriculated school counseling students only)  
The second semester of a two-semester field-based experience in a school setting, the school counseling internship includes work at the internship site, individual and group supervision, and attendance at weekly university seminars. Seminar topics vary and include working with diverse populations, handling crises that may arise during the internship, working with parents and teachers, and other topics that interns may wish to discuss. Taken in the last year of a student's program. (Offered: Every spring)  
(Offered: Spring)

EDF 453. Practicum in Applied Behavioral Analysis  
Prerequisites: (Restrictions: Restricted to students matriculated in an ABA program.)  
(Offered: Fall, Spring, Summer, SummerA, SummerB)

EDF 458. Supervised Internship in Community Mental Health Counseling  
Prerequisites: [EDF450]  
(Restrictions: Matriculated community mental health counseling students only)  
The Community Mental Health Counseling Internship, which meets the internship requirements for both Mental Health Counseling Licensure in New York State and accreditation by the Council for Accreditation of Counseling and Related Educational Programs (CACREP), is a 900 hour, field-based experience in a community mental health setting. Experiences in the internship site include site-supervised individual and group counseling, client intake process, assessment, and treatment planning. The class also requires attendance at weekly university seminars, weekly group supervision by a university supervisor, and periodic individual supervision with a university-based supervisor. Seminar topics vary and include issues that are germane to the many challenging experiences of interns. This course is taken in the latter part of a student's program of study. (Offered: Fall, Spring, SummerA & B)

EDF 469. K-12 Tutoring Strategies  
(Offered: Occasionally)
EDF 488. Practicum in Online Teaching
Prerequisites: [EDE484; EDE486]
Provides students in the master’s or certificate program in online teaching with a mentored experience that allows them to put into practice what they’ve learned in previous coursework about online teaching. More specifically, students engaging in this practicum experience will be responsible for various aspects of online teaching, in authentic contexts (i.e., real courses/professional development offerings) and with ongoing support provided by a mentor. Students will also produce a number of artifacts related to this experience that will serve as evidence of their proficiency with specific aspects of online teaching. (Offered: Fall, Spring, SummerA & B)

EDF 490. Practicum in K12 Digitally-Rich Teaching
Prerequisites: EDE484A
Provides a mentored experience where students put into practice what they learned in previous coursework about digitally-rich teaching. Practicum participants design and implement, at a minimum, a pre-determined set of learning experiences that utilize specific digital tools and resources and report on these experiences, including related artifacts, in a digital portfolio that will serve as evidence of their proficiency with specific aspects of digitally-rich teaching. This practicum includes the design, implementation, and evaluation of a complete unit of study that makes the best use of digital resources. Students are able to complete these requirements over multiple semesters, as needed to complete a total of 3 credit hours. (Offered: Fall, Spring, SummerA)

EDF 497. Supervised Internship in Higher Education (variable credits)
Directed and supervised experiences in a higher education setting. (Offered: Fall, Spring, SummerA & B)

EDF 498. Supervised Internship in Educational Administration (variable credits)
Supervised experiences at both the building and district levels for the equivalent of 15 weeks of full-time work, as necessary to meet New York State requirements for administrative certification and CAEP accreditation standards. Includes the submission of an Internship Portfolio of standards-based activities and evidence. (Offered: Fall, Spring, SummerA & B)

EDF 558. Supervised Internship in Counselor Education I (Doctoral)
Prerequisites: [EDU553] (Restrictions: Doctoral students in counseling only)
Gain experience and skills as a counselor educator in a 300-hour, two-semester internship in which students provide instruction, group supervision, and individual supervision for master’s counseling students. A faculty member provides weekly supervision and periodic observation to doctoral students. Formerly “Supervised Internship in Teaching and Clinical Supervision” (Offered: Fall, Spring)

EDF 559. Supervised Internship in Counselor Education II (Doctoral)
Prerequisites: (Restrictions: Doctoral students in counseling only)
Deepens and broadens individual and group counseling skills. Students complete a 300-hour internship, done over one or two semesters, in which populations or interventions unfamiliar to the student are the focus of the experience. Students work in school, hospital, or community agency settings. Includes weekly individual supervision and periodic group supervision. (Offered: Fall, Spring)

EDF 560. Supervised Internship in Mental Health Counseling (Doctoral)
Prerequisites: (Restrictions: Doctoral students in counseling only)
Deepens and broadens individual and group counseling skills. Students complete a minimum 300-hour internship, done over one or two semesters, in which populations or interventions unfamiliar to the student are the focus of the experience. Students work in school, hospital, or community agency settings. Includes weekly individual supervision and periodic group supervision. (Offered: Fall, Spring, SummerA & B)