Official Bulletin
Graduate Studies
2014–2016

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
William E. Simon Graduate School of Business Administration
Margaret Warner Graduate School of Education and Human Development

The bulletin was prepared in the spring of 2014. 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.

The University of Rochester values diversity and is committed to equal opportunity for persons regardless of age, color, disability, domestic violence status, ethnicity, gender identity or expression, genetic information, marital status, military/veteran status, national origin, race, religion/creed, sex, sexual orientation or any other status protected by law. The University complies with all applicable non-discrimination laws in the administration of its policies, admissions, employment, and access to and treatment in University programs and activities.

Questions on compliance should be directed to the particular school or department and/or to the University’s Equal Opportunity Coordinator, University of Rochester, P.O. Box 270039, Rochester, New York 14627-0039.
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# Graduate Course Numbering System

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<th>Description</th>
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<tr>
<td>400–489</td>
<td>Master’s first-year-level courses</td>
</tr>
<tr>
<td>490–499</td>
<td>Master’s-level reading and research courses</td>
</tr>
<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>
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<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>
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<tr>
<td>998</td>
<td>Doctoral part-time enrollment status</td>
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<tr>
<td>999</td>
<td>Doctoral dissertation full-time enrollment</td>
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### Publications about Graduate Programs at the University of Rochester

Most colleges and schools of the University publish brochures or Official Bulletins 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. Most graduate programs have valuable information on their departmental 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>
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<tbody>
<tr>
<td>Departmental/Program brochures and online applications</td>
<td>University of Rochester</td>
</tr>
<tr>
<td></td>
<td>218 Lattimore Hall</td>
</tr>
<tr>
<td></td>
<td>P.O. 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>
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<thead>
<tr>
<th>Edmund A. Hajim School of Engineering &amp; Applied Sciences</th>
<th>Office of Graduate Studies</th>
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<tbody>
<tr>
<td>Departmental/Program brochures and online applications</td>
<td>University of Rochester</td>
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<tr>
<td>Institute of Optics brochure</td>
<td>218 Lattimore Hall</td>
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<tr>
<td></td>
<td>P.O. Box 270401</td>
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<tr>
<td></td>
<td>Rochester, New York 14627-0401</td>
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<tr>
<td></td>
<td>Email: <a href="mailto:graduate.admissions@rochester.edu">graduate.admissions@rochester.edu</a></td>
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<tr>
<td></td>
<td><a href="http://www.rochester.edu/college/gradstudies">www.rochester.edu/college/gradstudies</a></td>
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<table>
<thead>
<tr>
<th>Eastman School of Music</th>
<th>Associate Dean of Admissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official Bulletin</td>
<td>Eastman School of Music</td>
</tr>
<tr>
<td>(Graduate and undergraduate)</td>
<td>26 Gibbs Street</td>
</tr>
<tr>
<td></td>
<td>Rochester, New York 14604-2599</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.esm.rochester.edu/admissions">www.esm.rochester.edu/admissions</a></td>
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<table>
<thead>
<tr>
<th>School of Medicine and Dentistry</th>
<th>Offices for Graduate Education and Postdoctoral Affairs</th>
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<tbody>
<tr>
<td>Departmental/Program brochures and online applications</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>
</tbody>
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|                                                          | University of Rochester                               |
|                                                          | School of Medicine and Dentistry                      |
|                                                          | Director of Admissions                                |
|                                                          | Elmwood Avenue, Box 601A                              |
|                                                          | Rochester, New York 14642-0001                        |
|                                                          | Email: mdadmish@urmc.rochester.edu                    |
|                                                          | AMCAS: www.aamc.org                                  |

Publications about Graduate Programs at the University of Rochester
| 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 |

| William E. Simon Graduate School of Business Administration | Admissions Office  
| William E. Simon Graduate School of Business Administration  
| 305 Schlegel Hall  
| University of Rochester  
| P.O. Box 270107  
| Rochester, New York 14627-0107  
| (585) 275-3533  
| Email: admissions@simon.rochester.edu  
| or emba@simon.rochester.edu |

| PhD program | PhD Office  
| William E. Simon Graduate School of Business Administration  
| 4345 Carol Simon Hall  
| University of Rochester  
| P.O. Box 270100  
| Rochester, New York 14627-0100  
| (585) 275-2959  
| Email: phdoffice@simon.rochester.edu |

| Margaret Warner Graduate School of Education and Human Development | Admissions Office  
| Margaret Warner Graduate School of Education and Human Development  
| Raymond F. LeChase Hall  
| University of Rochester  
| P.O. 270425  
| Rochester, New York 14627-0425  
| (585) 275-3950  
| Email: admissions@warner.rochester.edu  
| www.warner.rochester.edu |
2014–2016 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.

<table>
<thead>
<tr>
<th>Fall Semester 2014</th>
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<tbody>
<tr>
<td>September 2</td>
</tr>
<tr>
<td>October 13</td>
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<tr>
<td>November 26</td>
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<td>December 21</td>
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<table>
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<tr>
<th>Spring Semester 2015</th>
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<tbody>
<tr>
<td>January 14</td>
</tr>
<tr>
<td>January 19</td>
</tr>
<tr>
<td>March 7</td>
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<tr>
<td>May 15–17</td>
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<table>
<thead>
<tr>
<th>Fall Semester 2015</th>
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</thead>
<tbody>
<tr>
<td>August 31</td>
</tr>
<tr>
<td>October 5</td>
</tr>
<tr>
<td>November 25</td>
</tr>
<tr>
<td>December 20</td>
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</table>

<table>
<thead>
<tr>
<th>Spring Semester 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 13</td>
</tr>
<tr>
<td>January 18</td>
</tr>
<tr>
<td>March 5</td>
</tr>
<tr>
<td>May 13–15</td>
</tr>
</tbody>
</table>

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

Graduate Education

The University of Rochester is an independent university which offers over 50 doctoral programs and some 65 master’s programs in the following schools and colleges:

- 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
- William E. Simon Graduate School of Business Administration
- 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 continuing goal of the University is to prepare promising students for outstanding scholarly and professional achievement—by educating them in the technical skills of a discipline and in the moral values of intellectual life. To this end, the University has been heavily endowed by many benefactors, including George Eastman, founder of Eastman Kodak; Joseph Wilson, founder of Xerox; and Charles F. Hutchison. Today, the University is one of the most highly endowed universities in the nation.

In 2013–14, the University had 1,329 tenure track faculty and roughly 9,300 full-time and 1,700 part-time students. Of the full-time students, 5,837 were undergraduates and 3,471 were graduate students. These graduate students were part of all seven schools in more than 100 programs.

Admission is selective so that graduate students are both academically and intellectually outstanding. As a result, intellectual life within each program can be both intimate and challenging. At the same time, it is possible—and in fact quite common—for students to reach out to other disciplines for scholarly growth.

The great advantage of the University of Rochester is that it offers academic excellence on a personal scale. It is a university that spans the universe of knowledge—yet provides a wealth of opportunities for individual achievement and recognition.

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 House: The University of Rochester and George Eastman House have a long history of collaboration in both teaching and research. In the 1970s, a joint University of Rochester–Eastman House committee received funding from the National Endowment for the Humanities to develop a film studies curriculum at the University using Eastman House archives. Since that time, teaching on both campuses by Rochester faculty and Eastman House curators has continued in the areas of film and media studies, art history, and other disciplines. Beginning in 2005, Rochester faculty and Eastman House 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.
Graduate Student Life

Graduate and Family Housing

Members of the University of Rochester graduate student community can choose from a wide range of living accommodations close to campus in our graduate and family housing areas.

The University maintains apartment complexes that serve graduate students, medical students, and postgraduate trainees (including postdoctoral trainees and fellows, hospital house staff, and fellows of the School of Medicine and Dentistry).

For more information on graduate and family housing, contact the University Apartments Office at (585) 275-824 or by email at uapts@reslife.rochester.edu or check the website at www.rochester.edu/reslife, select Graduate from the menu.

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. Individuals may apply for graduate housing, but the University Apartments Office will confirm that the person is officially enrolled at the University of Rochester at the time of the offer. Because applications for University housing usually exceed available University facilities, a lottery system is used to establish priority among qualified applicants.

The Office of Residential Life and Housing 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. Select Off Campus from the menu.

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 this policy. Students are encouraged to consult the specific administrative offices within their respective schools regarding tuition, fees, financial aid, and course credit details.

Parental Leave

Graduate students are eligible for up to eight weeks of leave for the primary caregiver following the birth or adoption of a child.* During this period, students may postpone course assignments, examinations, and other academic requirements but remain active full-time students, with access to University facilities (including student health insurance, library privileges, and housing) and to University faculty and staff.

While students will continue to be funded at their current pay rate off any existing funding sources (e.g., fellowship, assistantship) during the leave period, students will be excused from regular teaching or research duties.† However, it is the students’ professional responsibility to work with their advisor or faculty member to prepare for the absence in advance of the leave. This includes reviewing the status and continuation of research projects, adequately preparing those who will assume teaching responsibilities during the students’ absence, and arranging for a smooth transition in any other responsibilities. Note that the students’ teaching, research, or other responsibilities may be altered for the semester in which the parental leave is taken.

Eligible graduate students are required to notify their advisor and school dean of graduate studies of the date of their intended time away at least 60 days prior (when possible) to the expected date of childbirth or adoption, using the Parental Leave Request Form. While applications for parental leave are required, the benefit is automatic.

If extended time is needed beyond the eight weeks leave, written approval for an unpaid leave of absence must be requested, and approval obtained from the students’ advisor, program director, and the school’s dean of graduate studies. Note that individual fellowships, such as the NSF Graduate Fellowships, may require sponsor approval for extended leaves of absence. Specific guidelines should be consulted. Students on the University of Rochester student medical health insurance plan should note that coverage is not provided for students while on a leave of absence.

Childcare Options

The Children’s School @ URMC is a KinderCare center located on the University of Rochester campus. As a national leader in managing employer-sponsored childcare centers, quality and curriculum are the cornerstones of KinderCare’s success in preschool education and childcare service. Their curriculum is based on a philosophy of Whole Child Development, centered on the belief that children learn through play and that every child is unique and develops in four distinct areas: social, physical, intellectual, and emotional. You may visit KinderCare’s website at www.kindercare.com; to find The Children’s School @ URMC, enter the zip code location of 14642.

The Children’s School @ URMC
55 Castleman Road
Rochester, NY 14620
(585) 273-3677

Additionally, the University of Rochester Office of Human Resources can provide a list of recommended day care centers in the area: www.rochester.edu/working/hr/familycare/.

Lactation Rooms

A lactation room is available at the University of Rochester Medical Center for graduate students to use to express their milk or breastfeed their child. All University employees and students can use the room by calling 275-4058 to obtain swipe access to the room. The room, which is available 24/7, can accommodate four

* These guidelines are consistent with the NIH Grants Policy Statement—parental leave (10/10). For those on NIH training grants, the use of parental leave must be approved by the Training Grant PD/PI.† NIH provides support for administrative supplements to hire temporary technical help for the grant to cover the absence of someone working on the grant due to family leave. See the following websites for more details: http://funding.niaid.nih.gov/researchfunding/traincareer/pages/ptas.aspx.
women at the same time. There are lounge chairs, breast pumps, lockers, and a refrigerator for women to store their milk if they care to. The room is located near the green elevators, on the first floor, 1-2226. Students can also use Room G-7644, accessible after obtaining the access code (call 275-7923). The River Campus has two locations, as well: Dewey Hall Annex, fourth floor and Wallis Hall second floor.

Family Counseling
The University Counseling Center (UCC) provides individual and couples therapy and yearlong group therapy to members of the University of Rochester community who pay the mandatory student health fee. Support is available for those looking to manage the changes in their lives that occur with the birth or adoption of a child: www.rochester.edu/ucc/index.html.

Graduate Student Organizations
Graduate student organizations are as follows: Arts, Sciences & Engineering, Graduate Organizing Group; Eastman School of Music, Graduate Student Association; School of Medicine and Dentistry, Graduate Student Society; School of Nursing, Doctoral Student Forum; William E. Simon Graduate School of Business Administration, Graduate Business Council; Margaret Warner Graduate School of Education and Human Development, Warner Graduate School Student Association and the Higher Education Student Association.

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

Access to medical and mental health care is provided 24 hours a day, seven days a week, throughout the calendar year. Whenever UHS and UCC offices are closed, a physician and a mental health professional are on call and available by phone for urgent concerns. To reach the physician on call, students should call UHS at (585) 275-2662. To reach the mental health professional, students are asked to call UCC at (585) 275-5113.

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; time-limited therapy 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: covers the cost of services such as surgical procedures, hospitalization, and diagnostic laboratory tests and X-rays. 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 or they can waive the insurance if they are covered by health insurance that meets University standards. To be eligible for waiver of the University-sponsored insurance, the students’ insurance plan must meet University criteria. The criteria are listed on the UHS website. Requests to waive the University-sponsored insurance may be audited to assure compliance with University standards for health insurance. Most international-based companies are not eligible for waiver. Students with international-based insurance can submit an appeal to have their insurance considered for waiver. Students who waive the health insurance are responsible for paying any charges that the University-sponsored plan would have covered. For questions about insurance offered through the University Health Service, check “Health Insurance for Full-Time Students” on the UHS website (www.rochester.edu). Students can also contact the UHS Insurance Advisor at insurance@uhs.rochester.edu for assistance.

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. Students who are unable to complete the immunization requirements before arriving on campus can do so at the University Health Service (UHS). Since this is a pre-matriculation requirement, students will be charged for the visit and the immunizations. 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. A late fee will be charged to students who do not complete the requirements by the first day of classes. For questions about completing the immunization requirement, write to hhf@uhs.rochester.edu.

University Health Service (UHS)
UHS provides a full range of primary 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.

The UHS primary care staff includes registered nurses, nurse practitioners, and physicians who are specialists in internal medicine and family medicine. To provide students with a more personal and effective interaction, all students are assigned a primary care provider (PCP) at UHS when they begin studies at the University. Students are encouraged to schedule appointments with their PCP when they need health care.
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 serious 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.

Locations
The University Health Service has three offices. The office on the River Campus is in the UHS Building, which is next to Susan B. Anthony Residence Halls. The office in the Medical Center is located in 1-5077 in the Medical Center. The office at the Eastman School of Music is located in Room 106 in the Student Living Center. Office locations and hours are listed on the UHS website (www.rochester.edu/uhs). Appointments at any UHS office are made by calling (585) 275-2662.

After-Hours Medical Care
Access to medical care is provided for students through the University Health Service 24 hours a day. Throughout the year, whenever the UHS offices are closed, a UHS physician is on call and available by phone, (585) 275-2662, from home for urgent concerns that cannot wait until the offices reopen. Unless it is an extreme emergency or a life-threatening situation, students should always call the University Health Service before seeking medical care elsewhere.

Health Promotion
The UHS Health Promotion Office promotes the health and wellness of students by providing educational programs and activities that encourage the development of a healthy lifestyle and the effective use of health care services. The UHS Health Promotion Office provides opportunities for students to become involved in learning and educating their peers. For more information, check “Health Promotion” on the UHS website (www.rochester.edu/uhs) or call (585) 273-5775.

UHS Website (www.rochester.edu/uhs)
The UHS website provides detailed information about the services provided by UHS, the locations and hours, the clinical staff, the mandatory health fee, health insurance, and health promotion services. In addition, the site provides links to online health care resources.

University Counseling Center (UCC)
The University Counseling Center (UCC) offers time-limited individual and couples therapy and yearlong group therapy to full-time students. Students use UCC services for a variety of problems including anxiety, apprehension about major life decisions, depression, relationship difficulties, family problems, eating problems, grief, sexual functioning, sexual identity, and general discomfort about what is happening in their lives. In addition to working with individuals and couples, the University Counseling Center offers a variety of therapy/support groups on such topics as women’s issues, men’s issues, adult children of alcoholics, survivors of sexual abuse, bereavement, and students with eating disorders. Staff members are also available to discuss topics or concerns of special interest to groups of students.

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. Therapists are available 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.

Locations
The University Counseling Center (UCC) is located on the third floor of the UHS Building on the River Campus. UCC also has offices at the Eastman School of Music and in the Medical Center. For office locations and hours, check the UCC website at www.rochester.edu/ucc. Appointments are made by calling (585) 275-3113.

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 distressed 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 locations, hours, services offered for students, staffing, online resources, self-help, and more. Mental health questions can be addressed to the UCC online resource, “Dear Dr. Ana-Lyze.” Designed as a forum for discourse on mental health concerns, this site is to be used strictly as an educational tool and in no way attempts to replace formal therapy.

Student Support
Teaching and Learning
The Center for Excellence in Teaching and Learning (CETL) is based in Arts, Sciences & Engineering and is open to all graduate students. CETL provides individualized support to students and faculty seeking to prepare for faculty roles, enhance their instructional skills, or meet diverse learning needs. CETL offers workshops for graduate students, including classroom and laboratory teaching assistants. CETL also is the University’s link to CIRTL, a national consortium of university-based programs and resources to advance effective teaching practices, with a focus on the STEM disciplines.
**Disabilities**

A student seeking disability-related accommodations can initiate a process of documenting the disability and arranging for accommodations by disclosing the concern in confidence to the Disability Coordinator in the relevant school. The Disability Coordinators for all schools are listed at [www.rochester.edu/eoc/DisabilityCoordinators.html](http://www.rochester.edu/eoc/DisabilityCoordinators.html).

Students who have questions or concerns about a documented or self-identified disability and wish to discuss them with someone outside the school may contact the University Intercessor at 275-9125 for a confidential discussion.

A number of University-wide resources are available for students with disabilities and the faculty and staff who support them. The Intercessor/Coordinator of University Disability Resources (275-9125) works closely with the Disability 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. The Director of Equal Opportunity Compliance (275-7814) maintains a website on the University’s compliance with the Americans with Disabilities Act (ADA) ([www.rochester.edu/eoc/resources/index.html](http://www.rochester.edu/eoc/resources/index.html)) including relevant information about disabilities and accommodations. CETL also provides a range of programs and services for students and their faculty to apply innovative accommodations and enhance the learning experience of students with disabilities ([www.rochester.edu/College/cetl/faculty/disability/accomodations.html](http://www.rochester.edu/College/cetl/faculty/disability/accomodations.html)).

**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 (275-9125 or [www.rochester.edu/intercessor/solving.html](http://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 approximately 2,400 international students and 600 scholars and employees plus their dependents from more than 110 countries. The staff administers the F-1, J-1, H-1B, O-1, and TN visa programs. The ISO supports admitting and hiring departments and issues visa documents, provides advice on immigration regulations affecting internationals, and processes immigration benefits such as employment authorizations and extensions of stay. The ISO is the University’s official liaison with the U.S. Department of Homeland Security, the Student Exchange Visitor Program (SEVIS), the Department of State, and foreign and American consulates and embassies, as well as offices of local government agencies such as the Social Security Administration and the Department of Motor Vehicles. The ISO works closely with members of the University community to advocate for and address the various needs of international students and scholars.

The ISO also serves as a resource to help internationals and their dependents adjust to the United States, the University, and the community of Rochester. Services and programs include individual immigration check-ins; new student orientation programs; individual advising and counseling appointments; a biweekly email newsletter; travel, employment, and tax workshops; pre-arrival and living in Rochester information; and a comprehensive website ([www.iso.rochester.edu](http://www.iso.rochester.edu)). The ISO is located in 213 Morey Hall and can be contacted by phone at (585) 275-2866 and by email at 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.

In order to provide direction in achieving the stated aims of the policy, an Environmental Health and Safety Department was formed. The department director is the chief safety officer for the University as well as the safety officer for Strong Memorial Hospital.

The 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; chemical waste disposal and environmental compliance through the Environmental Compliance Unit; and radiation safety issues through the Radiation Safety Unit. Within the several areas of expertise, these units provide guidance, consultation and training, and perform inspections and tests of facilities and procedures.

Heavy reliance for ongoing safety programs is placed on departments and similar major subdivisions of the University, in recognition of the very wide diversity of interests of these subdivisions, and equally, to minimize the surveillance and policing stigma commonly attached to safety departments.

**Interfaith Chapel**

The Interfaith Chapel is the center for religious and spiritual life on the River Campus. The chapel staff offers graduate student opportunities for worship and meditation, social service, personal counseling, and spiritual and cultural events. For further information, visit our website [www.rochester.edu/chapel/](http://www.rochester.edu/chapel/) or our Facebook page [www.facebook.com/URiChapel?ref=hl](http://www.facebook.com/URiChapel?ref=hl) or call 275-4321.

**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. You can obtain a copy of this report, titled Think Safe, by calling (585) 275-3340 or view the contents by accessing the following website: 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 investigative services, call (585) 275-3436. For victim’s assistance services, call (585) 275-2090.

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 fax (585) 275-0344, 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) 273-5200.

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): 4_info@security.rochester.edu
- Special Events: (585) 275-1087
- Lost/Found Property: (585) 275-2552
- Victim Assistance Coordinator: (585) 275-2090

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.

Rates for the 2014–2015 academic year are shown below and are subject to revision.

Rates for 2015–2016 may be different from the rates shown below; if so, new information about tuition and fees will be issued.

Tuition

<table>
<thead>
<tr>
<th>Full-Time Graduate Tuition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts, Sciences &amp; Engineering and the School of Medicine and Dentistry MS and PhD programs</td>
<td>$1,442/credit hour</td>
</tr>
<tr>
<td>Technical Entrepreneurship &amp; Management</td>
<td>$1,694/credit hour</td>
</tr>
<tr>
<td>Margaret Warner Graduate School of Education and Human Development</td>
<td>$1,296/credit hour</td>
</tr>
<tr>
<td>School of Nursing</td>
<td>$1,292/credit hour</td>
</tr>
<tr>
<td>William E. Simon Graduate School of Business Administration</td>
<td>$1,694/credit hour</td>
</tr>
<tr>
<td>School of Medicine and Dentistry (MD program)</td>
<td>$48,400 (annual)</td>
</tr>
<tr>
<td>Eastman School of Music</td>
<td>$1,425/credit hour*</td>
</tr>
<tr>
<td>$899: master’s dissertation, per semester</td>
<td>$1,050</td>
</tr>
<tr>
<td>$999: doctoral dissertation, per semester</td>
<td>$1,050</td>
</tr>
<tr>
<td>Each of the above, Eastman School of Music, per semester</td>
<td>$1,050</td>
</tr>
<tr>
<td>Each of the above, Simon School, per quarter</td>
<td>$500</td>
</tr>
</tbody>
</table>

The tuition for full-time graduate students covers courses receiving graduate credit and includes fees for laboratory courses. It does not include courses unrelated to the student’s academic program for which the student wishes academic but not graduate credit.

Part-Time Graduate Tuition

<table>
<thead>
<tr>
<th>Nonmatriculated students in the School of Arts and Sciences†</th>
<th>$812/credit hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edmund A. Hajim School of Engineering &amp; Applied Sciences</td>
<td>$1,442/credit hour</td>
</tr>
<tr>
<td>Eastman School of Music excluding applied music courses</td>
<td>$1,425/credit hour</td>
</tr>
<tr>
<td>Applied music courses</td>
<td>varies</td>
</tr>
<tr>
<td>School of Medicine and Dentistry</td>
<td>$1,442/credit hour</td>
</tr>
<tr>
<td>School of Nursing</td>
<td>$1,292/credit hour</td>
</tr>
<tr>
<td>William E. Simon Graduate School of Business Administration</td>
<td>$1,694/credit hour</td>
</tr>
<tr>
<td>Margaret Warner Graduate School of Education and Human Development</td>
<td>$1,296/credit hour</td>
</tr>
</tbody>
</table>

* Per credit hour rate does not apply to music lessons. Cost for music lessons varies. Please verify charges with the associate director for administration (274-1030).
† Maximum of one course taken as nonmatriculated student may be approved for use in graduate program for matriculated arts and sciences graduate student.

Fees

The fee for auditing courses is $176 per credit hour, except for courses in the Simon School and the Eastman School of Music. The auditing fee for the Eastman School of Music is $176 per course. The Simon School’s auditing fee is $2,544 per course.

Senior citizens (age 60 and over) and alumni will receive a discount of $250 for each credit-bearing course and $100 per audited course. Alumni who are senior citizens will receive a $500 discount for each credit-bearing course and $200 per audited course (this discount does not apply at Simon School). These discounts apply only to nonmatriculated students.
### Other Fees

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory Health Service Fee charged to all full-time students</td>
<td>$504</td>
</tr>
<tr>
<td>Late registration fee*</td>
<td>$160</td>
</tr>
<tr>
<td>Thesis Archive fee for the EdD degree before registering the dissertation</td>
<td>$70</td>
</tr>
<tr>
<td>Health History Form late fee</td>
<td>$50</td>
</tr>
<tr>
<td>895: continuation of master's enrollment, per semester</td>
<td>$1,050</td>
</tr>
<tr>
<td>995: continuation of doctoral enrollment, per semester</td>
<td>$1,050</td>
</tr>
<tr>
<td>For William E. Simon Graduate School of Business Administration, 995, per quarter</td>
<td>$500</td>
</tr>
<tr>
<td>For Eastman School of Music, 895 and 995, per semester†</td>
<td>$1,050</td>
</tr>
<tr>
<td>985: leave of absence, per semester for AS&amp;E and Nursing</td>
<td>$60</td>
</tr>
<tr>
<td>For the Eastman School of Music and School of Nursing</td>
<td>$100</td>
</tr>
</tbody>
</table>

Noncredit course fees. All persons attending noncredit courses must pay fees as announced for these courses.

* Registration must be completed for all credit-carrying courses and research by the end of the second week of classes after the semester begins, or a penalty charge is assessed. Registration deadlines for matriculated students in the School of Nursing may vary. For specific deadline dates, call the School of Nursing registrar at 275-8832.
† Please verify all Eastman School of Music tuition charges with the associate director for administration at 274-1030.

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### Payment Policy

For nonmatriculated students, one-half the amount due the University for a semester is due at the time of registration, and the remaining balance is due by the 10th of the following month. For matriculated students, and students enrolled in the William E. Simon Graduate School of Business Administration, the University offers a two-payment plan each semester/quarter. A fee of 1 percent of any unpaid amount is charged for each month or part of a month that payment remains past due. For additional information, students should contact the Bursar, University of Rochester, Rochester, New York 14627-0037; (585) 275-3931. Students in the School of Medicine and Dentistry should contact the Bursar, School of Medicine and Dentistry, 601 Elmwood Avenue, Rochester, New York 14642-8601; (585) 275-4672.

### 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, Financial Aid, and other appropriate offices to adjust the student’s accounts.

Refund schedules are available on the Bursar Web site: [www.rochester.edu/adminfinance/bursar](http://www.rochester.edu/adminfinance/bursar).

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 award will be reduced in the following order: Unsubsidized Federal Direct Loan, Subsidized Federal Direct Loan, Federal Perkins Loan, Federal PLUS Loan, Federal Pell Grant, Federal SEOG. Additional adjustments may be made to state aid, private aid, and 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 University awards 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. 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 may 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 up to a maximum of $20,500 per academic year 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). To apply for a federal loan, students must complete the Free Application for Federal Student Aid (FAFSA) online at www.fafsa.ed.gov.

Additional Aid Options: The federal Graduate PLUS loan is based on credit-worthiness, which is determined by the federal government. There is a fixed interest rate of 7.9 percent. There is no grace period associated with the loan, but students may defer payments while they are enrolled at least part time. Applications are available online at www.studentloans.gov. Students must have already applied for the federal Direct Unsubsidized loan before applying for the federal Graduate PLUS loan program.

Students may opt for a private or alternative loan instead of the suggested federal loans. Please be aware that these loans are based upon credit-worthiness and have variable interest rates, as determined by the individual lenders. Students must complete an application and be approved by the lender of their choice before funds will disburse to their student account. Please be aware that a co-borrower may be required for some students.

For additional information on loan options, please contact the Financial Aid Office.

Please contact the appropriate school for financial aid application instructions:

If you are applying to the Eastman School of Music, please contact: Office of the Director of Financial Aid, Room 103, Eastman School of Music, 26 Gibbs Street, Rochester, New York 14604-2599.

If you are applying to the School of Medicine and Dentistry, please contact: Office of Financial Aid, School of Medicine and Dentistry, 601 Elmwood Avenue, Box 601, Rochester, New York 14642-0001.

All other schools and colleges of the University (the School of Arts and Sciences, the Hajim School of Engineering and Applied Sciences, the Warner School of Education, the Simon School of Business, and the School of Nursing): Financial Aid Office, University of Rochester, P.O. Box 270261, Rochester, NY 14627-0261. Phone number: (585)275-3226.
Graduate Degrees

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. Information about specific graduate programs is available elsewhere in this bulletin and at www.rochester.edu/gradstudies.

The Degree Doctor of Philosophy

The requirements for the degree of Doctor of Philosophy are described in the section of this Bulletin titled "Regulations and University Policies Concerning Graduate Study."

The degree Doctor of Philosophy is awarded by the University of Rochester in the following subjects:

School of Arts & Sciences
- Biology
- Brain and Cognitive Sciences
- Chemistry
- Economics
- English
- Geosciences
- History
- Linguistics*
- Mathematics
- Philosophy
- Physics
- Physics and Astronomy
- Political Science
- Psychology (Clinical, Developmental, and Social-Personality)
- Visual and Cultural Studies

Edmund A. Hajim School of Engineering & Applied Sciences
- Biomedical Engineering
- Chemical Engineering
- Computer Science
- Electrical Engineering
- Materials Science
- Mechanical Engineering
- Optics

Eastman School of Music
- Music Composition
- Music Education
- Music Theory
- Musicology

School of Medicine and Dentistry
- Biochemistry
- Biophysics
- Epidemiology
- Genetics
- Health Services Research and Policy
- Microbiology and Immunology
- Neurobiology and Immunology
- Neuroscience
- Pathology
- Pharmacology
- Physiology
- Statistics
- Toxicology
- Translational Biomedical Science

School of Nursing
- Health Practice Research

William E. Simon Graduate School of Business Administration
- Business Administration

Margaret Warner Graduate School of Education and Human Development
- Education

The Degrees Doctor of Musical Arts, Doctor of Medicine, Doctor of Nursing Practice, and Doctor of Education

Information and requirements for the Doctor of Musical Arts at the Eastman School of Music may be found at www.esm.rochester.edu; for the Doctor of Medicine at the School of Medicine and Dentistry, www.urmc.rochester.edu/smd; Doctor of Nursing Practice at the School of Nursing, www.son.rochester.edu; and for the Doctor of Education at the Margaret Warner Graduate School of Education and Human Development, www.warner.rochester.edu.

The Degrees of Master of Arts and Master of Science

The master's degree is awarded in arts, science, engineering, music, medical sciences, nursing, business administration, and education. The administration of work for the master's degree is vested in the associate dean for graduate studies and the Committee on Graduate Studies in each school or college. Two plans of study are available to students working toward the master's degree. A candidate for the degree in Plan A must complete a dissertation and pass an oral examination on the dissertation. Under Plan B, a dissertation is not required; but most departments require that a candidate for the degree in Plan B pass a comprehensive examination. It is recommended that the individual check with the relevant department for its requirements. The list below indicates whether the degree can be completed under Plan A, Plan B, or either.

* New enrollments suspended.
Other requirements for master's degrees are described in the section of this bulletin titled "Regulations and University Policies Concerning Graduate Study."

**School of Arts & Sciences**

- Biology (MS) A,B
- Brain and Cognitive Sciences (MA) A,B
- Chemistry (MS) A,B
- Comparative Literature (MA) A,B
- Economics (MA) B
- English (MA) B
- French (MA) A,B
- Geological Sciences (MS) A,B
- German (MA) A,B
- History (MA) A,B
- Interdepartmental Studies (MA, MS) A,B
- Linguistics (MA) A,B
- Literary Translation (MA) A
- Mathematical Methods (MS) B
- Mathematics (MA) B
- Mathematics-Applied (MS) A,B
- Mathematics-Statistics (MA) B
- Philosophy (MA) A,B
- Photographic Preservation and Collection Management (MA)
- Physics (MA) B, (MS) A
- Political Science (MA) A,B
- Psychology (MA) A,B
- Spanish (MA) A, B
- Visual and Cultural Studies (MA) B

**Edmund A. Hajim School of Engineering & Applied Sciences**

- Alternative Energy (MS)
- Biomedical Engineering (MS) A,B
- Chemical Engineering (MS) A,B
- Computer Science (MS) B
- Electrical Engineering (MS) A,B
- Materials Science (MS) A,B
- Mechanical Engineering (MS) A,B
- Optics (MS) A,B
- Technical Entrepreneurship and Management (MS)

**Eastman School of Music**

- Ethnomusicology (MA)
- Music Composition (MA) A
- Music Education (MA) A
- Music Education with Initial Certification (MA)
- Music Education with Professional Certification (MA)
- Music Theory (MA) B
- Music Theory Pedagogy (MA) B
- Musicology (MA) B

**School of Medicine and Dentistry**

- Biochemistry (MS) A,B
- Biophysics (MS) A,B
- Clinical Investigation (MS) A
- Clinical Translational Research (MS) A
- Dental Science (MS) A
- Genetics (MS) A,B
- Marriage and Family Therapy (MS) A,B
- Medical Informatics (MS)
- Medical Statistics (MS) B
- Microbiology-Medical (MS) A,B
- Neurobiology and Anatomy (MS) A,B
- Neuroscience (MS) A,B
- Pathology (MS) A
- Pharmacology (MS) A,B
- Physiology (MS) A,B
- Statistics (MA) B
- Toxicology (MS) A,B

**School of Nursing**

(offered as traditional and accelerated programs)

- Acute Care Nurse Practitioner (MS) B
- Adult Nurse Practitioner (MS) B
- Adult Nurse Practitioner/Geriatric Nurse Practitioner (MS) B
- Care of Children and Families—Pediatric Nurse Practitioner/ Neonatal Nurse Practitioner (MS) B
- Care of Children and Families—Pediatric Nurse Practitioner/ Pediatric Behavioral Health (MS) B
- Care of Children and Families—Pediatric Nurse Practitioner (MS) B
- Clinical Nurse Leader (MS)
- Family Nurse Practitioner (MS) B
- Leadership in Health Care Systems (MS) B
- Child and Adolescent Psychiatric Mental Health Nurse Practitioner (MS) B
- Pediatric Nurse Practitioner/Psychiatric/Mental Health Nurse Practitioner (MS) B
- Psychiatric/Mental Health Nurse Practitioner (MS) B

**William E. Simon Graduate School of Business Administration**

- Accountancy (MS)
- Business Administration (MS) A
- Finance (MS)
Margaret Warner Graduate School of Education and Human Development
School Counseling (MS)
Community Mental Health Counseling (MS)
Educational Policy (MS)
Higher Education Administration (MS)
Higher Education Student Affairs (MS)
Health Professions Education (MS)
Human Development (MS)
K–12 School Leadership (MS)
Teaching and Curriculum (MS)
Early Childhood Education (MS)
Childhood Education (MS)
Adolescence Education (MS)
TESOL/Teaching English to Speakers of Other Languages (MS)
Teaching Students with Significant Disabilities (MS)
Reading and Literacies (MS)
See www.warner.rochester.edu for specific degree offerings.

Other Master's Degrees
The University of Rochester offers other master’s degrees as follows:
1. Master of Business Administration through the William E. Simon Graduate School of Business Administration. (See page 265.)
2. Master of Music through the Eastman School of Music. (See page 167.)
3. Master of Arts in Teaching through the Margaret Warner Graduate School of Education and Human Development. (See page 297.)
4. Master of Public Health through the School of Medicine and Dentistry. (See page 232.)
Regulations and University Policies Concerning Graduate Study

Master's and Doctoral Degrees Offered at the University

The University offers the Doctor of Philosophy degree and administers the award of this degree centrally in the Office of the University Dean of Graduate Studies. The University also offers the degrees of Doctor of Education, Doctor of Medicine, Doctor of Musical Arts, and Doctor of Nursing Practice, which are administered by the respective schools. Requirements for the degree of Doctor of Education can be obtained from the Margaret Warner Graduate School of Education and Human Development (see www.warner.rochester.edu); for the degree of Doctor of Medicine in the School of Medicine and Dentistry, see www.urmc.rochester.edu/smd; for the degree of Doctor of Musical Arts in the Eastman School of Music, see www.esm.rochester.edu; and for the degree Doctor of Nursing Practice in the School of Nursing, see www.son.rochester.edu.

The master's degree is offered in arts, science, music, engineering, nursing, business administration, accountancy, and education. Information on master's degrees other than MA and MS can be found as follows: for the Master of Business Administration and Master of Science in Accountancy through the William E. Simon Graduate School of Business Administration, see www.simon.rochester.edu. For the Master of Music through the Eastman School of Music, see www.esm.rochester.edu, for the Master of Public Health through the Department of Community and Preventive Medicine in the School of Medicine and Dentistry, see www.urmc.rochester.edu/cpm.

Administration of Graduate Studies

As authorized by the Board of Trustees in a Charter for Administration of Graduate Studies, the provost assigns responsibility for the administration of all postbaccalaureate work within each school to the dean of that school, who may delegate it to an associate dean of graduate studies or to another appropriate official. (In these Regulations, the term “associate dean” is used to refer to the official overseeing graduate studies in a school, regardless of title.) Policies for graduate work within each school are determined by the respective faculties and their administrative officers in accordance with the provisions in these Regulations.

The University grants the Doctor of Philosophy degree and administers the award of this degree centrally in the Office of the University Dean of Graduate Studies. The general requirements for the PhD are set at the University level, as described later in this Bulletin. The Council on Graduate Studies recommends to the provost for transmission to the Board of Trustees all candidates for the Doctor of Philosophy degree.

Schools and interdisciplinary programs offer approved PhD programs under University policies described in this Bulletin. More specific requirements for degree programs may be set by individual schools and departments.

General requirements for the MA and MS degrees are set at the University level and described in this Bulletin. General requirements for other master’s degrees and specific requirements for all master’s degree programs are set by individual schools.

The administration of work for master’s degrees and for doctorates other than the PhD is vested in the associate dean of graduate studies and the Committee on Graduate Studies or equivalent in each school. Each school recommends its candidates for graduate degrees other than the PhD to the provost for transmission to the Board of Trustees. If a candidate for one of these degrees has taken work in more than one school in the University, the recommendation for award of the degree originates in the school responsible for the student’s major department or program.

University Policies for All Graduate Programs

Admission

Admission to graduate studies is granted to graduates of accredited colleges/universities, technical schools, and music schools who present satisfactory evidence of ability to pursue graduate study. Additional admission requirements are set by certain schools of the University. These are stated separately in the general announcements of each school in this bulletin.

An applicant’s qualifications are examined by the relevant department/program of major interest and by the associate dean of graduate studies in the appropriate school to determine
whether previous training and ability promise success in work for advanced degrees. Individual departments, with the approval of their associate deans for graduate studies, may limit the number of graduate students to be admitted, determine the credit hours of prerequisite study, stipulate language requirements, or set other special admission requirements.

Admission to a graduate degree program at the University of Rochester is for that program alone. Admission to any other program requires a completely new admissions application.

In certain cases, applicants who do not meet all the requirements for admission may be admitted conditionally. Their standing is reviewed after the first term of study to decide on their continuation in graduate work. Occasionally, a student without a bachelor’s degree is admitted to a graduate program because of demonstrated high academic competence; such students are considered graduate students.

Special students have satisfactory undergraduate records except that they lack prerequisite courses for the intended area of graduate study. Such prerequisites must be completed within a year, and a student will not be continued as a special student beyond this time. Enrollment as a special student does not guarantee subsequent admission and matriculation with full graduate-student status.

Probationary admission may be granted to a student whose credentials indicate only marginal preparation for graduate work, on approval of the associate dean of graduate studies in the appropriate school and the department of major interest. Such a student can be admitted to full standing upon completing, at the discretion of the department, from 12 to 24 semester hours of graduate credit with all grades of at least B. If the student receives any grade lower than B, enrollment in graduate studies is subject to termination. (For School of Nursing, see Student Handbook relating to probation policies.)

A person wishing to take a graduate course or courses not leading to a degree may register as a nonmatriculated student. Approval of the associate dean is required for the Eastman School of Music; approval of the director of PhD programs for PhD courses for the School of Nursing. In the Simon School, approval of the associate dean is required for courses other than the four basic core courses. Subsequent evaluation of such work for inclusion in a graduate program is subject to the limitations on transfer credit stated in the sections that follow.

All full-time and part-time students taking 6 or more credit hours need to comply with University and New York State immunization requirements. Please see the University Health Service website (www.rochester.edu/uhhs) for specific requirements, health history form, and immunization requirement link.

Registration

A matriculated graduate student is one who has been admitted to a graduate degree program and has completed initial registration in that program. Once matriculated, a graduate student must maintain continuous enrollment by registering each academic year semester (every quarter in the Simon School) and paying required fees until all requirements for the degree are completed. Auditing a course does not fulfill this requirement. Requirement for summer registration varies by program.

Registration must be completed within two weeks after the beginning of a semester for all courses that carry credit. Late registration is accepted with the payment of a late registration fee.

Dropped Courses

A regular semester course may be dropped at any time through the sixth week of classes, provided the student obtains the approval of his or her faculty advisor and the instructor(s), notifies the graduate registrar on the proper form, and the change does not alter the student’s time status. No record of such actions appears on the official transcript.

Following the start of the seventh week of classes, a drop notification (or a change from credit to audit) sent to the graduate registrar must bear the signatures of the faculty advisor, course instructor(s), and associate dean of graduate studies. Such late drops will be recorded on the official transcript and identified by the grade ‘W’. At the option of the course instructor, a grade of ‘E’ may also be attached.

In exceptional circumstances, the associate dean of graduate studies may approve dropping a course without record after the start of the seventh week of classes. Review of the circumstances is initiated by an appropriate written petition.

Dropping credit hours after the seventh week of a semester or retroactive after the conclusion of the semester is not permitted if the change affects the student’s time status (full-time status changes to part-time status) for that particular semester.

No academic credit is granted for courses in progress at the time a student withdraws from the University, except by explicit approval of the associate dean acting upon a written petition.

Audited Courses

Audit of a course related to a degree program is permitted for full-time and part-time graduate students, when approved by the student’s faculty advisor, the course instructor(s), and the associate dean of graduate studies. There is a fee for this. With the approval of the associate dean of graduate studies, the school may decide to pay this fee. The audited course will appear on the student’s transcript provided the student attends throughout the course. Students who wish later to receive credit for such a course may do so by (1) changing the registration in the office of the graduate registrar prior to the end of the sixth full week of classes in a given semester and (2) paying the required tuition for the course.

Full-time Status

A full-time graduate student is defined as a student who registers for at least 12 hours of credit for the semester (or 9 hours of credit for the quarter at the Simon School), or a graduate assistant or other student doing work equivalent to that of an assistant who registers for at least 9 hours of credit for the semester. Master’s students in the School of Nursing should consult the School of Nursing Student Handbook regarding credit requirements for full-time status.

Change of time status (i.e., full time to part time, or full time to x-time) requires approval from the associate dean, except for the Warner School and the School of Nursing.
Residency
A student is defined as being in residence at the University of Rochester if he or she is registered as a full-time student and is using the facilities of the University (laboratories, libraries, consultations with faculty members, or course attendance) with sufficient frequency and regularity to establish this status clearly. Some period of residence at this University is required for all advanced degrees. (See departmental residency requirements stated in this bulletin.)

Summer Residency Status
Requirements for registration during summer sessions vary across graduate programs. Any student who has been classified as full time during the preceding academic year and is registered for the summer is considered full time during the summer regardless of summer credit load. Students in residence but not registered for summer credit may register for “990: doctoral summer in residence” or “890: master’s summer in residence” and will not be subject to summer tuition charges.

Study in Absentia or Special Status
In certain circumstances it may be desirable for a matriculated graduate student to engage in full-time or part-time study or research for a limited period of time at a location away from campus while registered for graduate credit or dissertation status at the University of Rochester. All such requests must be made in writing. Advance approval by the associate dean of graduate studies may be required.

Credit Hour Policy
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.

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:

1. (o) 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.

Grades
Grades for graduate students are reported on one of two systems. One is A (excellent), A–, B+, B (good), B–, C (poor), and E (failure). The other is S (satisfactory) and E (failure). (See the bulletin of the Eastman School of Music for the grading system in effect for that School.)

The grade S may not be used for any student in a class in which the other students are graded on the A, A–, B+, B, B–, C, E scale (except “591” and “595”). Minimum grades for courses or research work carrying graduate credit are C or S. C is, however, considered to be a failing grade for any student who is on probation. Moreover, a student who receives the grade of C in each of two courses, or for eight hours of work toward the degree (even if only one course), will thereby have raised the question of the adequacy of his or her academic performance. In those circumstances the student’s record must be reviewed by the associate dean of graduate studies (in the School of Nursing, the Student Affairs Committee) in consultation with the student and the program director. Individual schools may have established higher minimum standards.

The following grades are also assigned to courses: I, assignments not completed, and W, withdrawal from a course.

Courses or research for which a student has registered and which are graded I (incomplete) must be completed within the time period stated by the professor. Matriculated graduate students in Arts, Sciences & Engineering should refer to the “Policies Governing Use of the Grade of Incomplete in Graduate Courses” in the relevant section of the Bulletin. It is the responsibility of the student to complete the work; the professor may replace the grade of incomplete with IE (failure) or with a passing grade at any time. Retroactive dropping of credit hours after the conclusion of a semester is not permitted if the change affects the student’s time status (full-time status changes to part-time status) for that particular semester.
Leaves of Absence

Leave of Absence (Non-Medical)
The associate dean of graduate studies may grant a leave of absence to a matriculated graduate student who has not yet completed all requirements for the degree. The leave will ordinarily be limited to one year. Students must register for “985; leave of absence” each semester they are in this category and must pay the designated fee. It should be noted that registration of “985; leave of absence” does count toward the degree time limit.

Leave of absence is an x-time category of registration, which has implications for health insurance eligibility, possible loan deferments, and visa status. X-time is defined as neither a full-time or part-time student, but is used to maintain a student’s place in their graduate program so that they will not be considered withdrawn by the University.

Medical Leave of Absence
On occasion, a serious health problem requires a student to go on inactive status before the end of a semester. In that situation, it may be reasonable to give the student a pro-rated refund on tuition and certain fees. Associated with this special consideration is the right of the University to determine (1) whether the leave is justified on medical grounds and (2) whether the student has recovered sufficiently to return at some point in the future.

Any student who wishes to start a medical leave of absence mid-semester must petition the student’s school. The school will then ask the University Health Service (UHS) to review relevant health-related information, some of which may have to be provided by the student. The director of UHS (or his or her designee) will make a recommendation to the school regarding the appropriateness of allowing the student to take a medical leave of absence. The recommendation will be based on the seriousness of the health problem and the extent to which the health problem has interfered with the student's coursework. Evidence of both is required.

The school will make the decision concerning the medical leave petition and will inform the student of that decision, including the effective date of the leave and any other conditions attached to it that are deemed appropriate to the circumstances of the particular case. Such conditions may include, for example, minimum and/or maximum length of time of the leave and/or requirements that must be met before the student can return from leave. Except in unusual situations, as determined by the school in its sole discretion, the petition to go on leave for medical reasons must be initiated by the student before the end of the semester in question.

A student who wishes to return from a medical leave of absence must petition the student’s school. The school will then ask the UHS to review relevant health-related information, some of which may have to be provided by the student. The director of UHS (or his or her designee) will make a recommendation to the school regarding the appropriateness of allowing the student to return from medical leave of absence. The recommendation will be based on evidence that the medical condition required the leave is controlled sufficiently to allow the student to make a successful return.

The school will consider that recommendation and whether any conditions imposed on the leave have been met, will decide on the student’s return, and will inform the student of its decision.

Except in unusual situations, as determined by the school in its sole discretion, the petition to return from medical leave of absence must be initiated by the student at least two and preferably three months before the expected date of return.

Students must register for “985; leave of absence” each semester they are in this category and must pay the designated fee. It should be noted that registration of “985; leave of absence” does count toward the degree time limit.

Involuntary Leave of Absence
The University of Rochester provides a wide range of services to support and address the mental and physical health needs of students including assessment, short-term care as appropriate, and referrals. Our first concern is for the health and welfare of each individual in our community. Our goal is to enable all of our students to participate fully as members of Rochester’s academic community.

However, students who disrupt the educational activities of the University community may be required to take a leave of absence from the University. Under these circumstances, students will be given the opportunity to take a voluntary leave. However, if a student declines to take a voluntary leave, the University may determine that the student’s welfare or the needs of the community require a period of involuntary leave. The following policy establishes the protocol under which an involuntary leave of absence may occur and the process for return from such a leave.

The University may place a student on an involuntary leave of absence or require conditions for continued attendance when the student exhibits behavior that harms or threatens to harm the health or safety of anyone within the University community; causes or threatens to cause significant property damage; or significantly disrupts the educational and other activities of the University community.

When a student exhibits any of the behaviors described above, the matter may be brought to the attention of the school associate dean of graduate studies (or designee), the University’s CARE Network (www.rochester.edu/care), or another University official. The official receiving the report is encouraged to use the resources of the College Dean of Students who serves as the judicial officer for the University. (See page 40 on Nonacademic Misconduct.) The associate dean of graduate studies (or designee) may place a student on an involuntary leave of absence or impose conditions upon the student’s continued attendance.

The associate dean of graduate studies (or designee) will seek an immediate assessment of the student’s ability to remain at the University. This assessment will be based on the student’s observed conduct, actions, and statements and may require consultation with the University Counseling Center (UCC), University Health Services (UHS), or other appropriate professionals regarding the student's circumstances.

The student will be notified that the associate dean of graduate studies (or designee) is seeking to determine whether he or she should be required to take a leave of absence. When reasonably possible, the student will be given the opportunity to confer with the associate dean of graduate studies (or designee) and to provide additional information for consideration.
The associate dean of graduate studies (or designee) will conclude the review of available information with a decision that may include the following:

- The student remain enrolled with no conditions;
- The student remain enrolled subject to conditions (including a description of those conditions); or
- The student be placed on an involuntary leave of absence.

If the associate dean of graduate studies’ (or designee’s) decision is to require an involuntary leave of absence, the decision will also indicate the length of the leave and describe the conditions (if any) under which the student may seek to return from leave. The student will then be withdrawn from active status by the associate dean of graduate studies.

The student shall be informed in writing by the associate dean of graduate studies (or designee) of the leave decision, the effective date of the leave, and conditions for return (if applicable). If a student is permitted to remain enrolled subject to conditions, the student shall be informed in writing of the effective date and the duration of the modified attendance.

**Appeal Process**

A student who is placed on Involuntary Leave may appeal the decision to the dean of the school or his or her designee within seven days of receipt of the letter notifying him or her of the involuntary leave. The appeal must be in writing, delineating the reasons why the student believes the decision is inappropriate. The dean of the school will review the student’s appeal and uphold, reverse, or alter the decision. The dean’s decision will be communicated to the student in writing and shall be considered final.

**Process for Return from Involuntary Leave**

A student seeking a return from leave must meet the conditions specified by the associate dean of graduate studies (or designee). The student must apply in writing to the associate dean of graduate studies. It is the responsibility of the associate dean of graduate studies to review the student’s compliance with specified conditions for the return from leave and to advise other University offices accordingly. Appropriate administrative duties with respect to commencing this leave process and maintaining its records will be the responsibility of the associate dean of graduate studies.

**Confidentiality Regarding Involuntary Leave**

All records concerning involuntary leaves of absence will be kept in accordance with the University confidentiality policy and other applicable policies. No statement regarding the leave of absence or withdrawal appears on the student’s official transcript.

**Withdrawal from a Degree Program**

The continuance of each student upon the rolls of the University, the receipt of academic grades, and the conferring of any degrees or the granting of any certificate are strictly subject to the discretionary powers of the University. Each student concedes to the University the right to require his or her withdrawal at any time for just cause.

Voluntary withdrawal from the University by a student who has not completed the degree program should be reported in writing by the student to the appropriate associate dean of graduate studies.

**Readmission and Rematriculation after Withdrawal**

Students who have withdrawn from work toward a graduate degree may apply for readmission. If readmitted, the student will be expected to reformulate a graduate program with the assistance of the faculty advisor and will be required to pay the stated rematriculation fee plus any other indebtedness previously incurred. Graduate courses completed successfully by the student prior to withdrawal may be counted as partial fulfillment of the requirements of the degree, provided:

A. the courses form an integral part of the student’s new program and are approved for inclusion by the faculty advisor; and

B. the courses were completed not more than five years prior to the date of application for rematriculation.

The maximum time for a rematriculated student to complete the program for the degree will be based on the credit hours remaining to be completed, computed at a rate of at least six credit hours a year. This does not negate the maximum time limit for the degree.

**Continuing Registration in Master’s or PhD Dissertation Phase**

All students must maintain continuous enrollment. If enrollment has been allowed to lapse, students must pay the appropriate fees for unregistered semesters in order to complete the degree.

MS, MA, or PhD students who have completed all credit requirements but not yet completed the final dissertation may register, with the approval of the advisor and the associate dean of graduate studies, for one of the categories below.

**999/899**

This status is utilized as follows:

- It is considered full-time enrollment for all reporting purposes and satisfies government requirements for F-1 and J-1 international students to maintain full-time enrollment.
- It is for students who are not enrolled in full-time coursework but are, nonetheless, working full time on their degree requirements (e.g., dissertation, thesis, degree recital, etc.).
- It includes a relevant fee (often a dissertation fee), as well as other fees associated with full-time enrollment.
- Students are registered with specific reference to a faculty advisor, who is ultimately responsible for monitoring their full-time effort.
- The student has either completed all requirements for the degree other than the thesis or is enrolled in final coursework in addition to the work necessary for the degree requirements (e.g., dissertation, degree recital, etc.).
- The student has actively demonstrated full-time effort, whether through being physically located on campus or having completed the appropriate petitions to demonstrate full-time effort elsewhere in the U.S. (999A/899A) or abroad (999B/899B).
- Mandatory Health Fee is not required if the student is studying in absentia (e.g., 999A/899A) and the student is not enrolled in the University health insurance.
- International students utilizing the in absentia options must coordinate with ISO for immigration purposes.
- Students are eligible for federal loans.
- Students are eligible for University health insurance.

998/898
This status is utilized most often by the Warner School and can be applied as follows:
- It is considered part-time (at least half-time) enrollment for all reporting purposes.
- This dissertation category does not satisfy government requirements for F-1 and J-1 international students to maintain full-time enrollment and will require that students obtain advanced permission for a Reduced Course Load, if eligible.
- It is for students who are not enrolled in half-time coursework but are, nonetheless, working at least half time on their degree requirements (e.g., dissertation, thesis, degree recital, etc.).
- It includes a relevant fee (often a dissertation fee).
- Students are registered with specific reference to a faculty advisor, who is responsible for monitoring their part-time effort.
- The student has either completed all requirements for the degree or is enrolled in final coursework in addition to the work necessary for degree requirements (e.g., dissertation, degree recital, etc.).
- Students are eligible for federal loans.
- Students are not eligible for University health insurance.

997/897
This status is utilized as follows:
- It is considered full-time enrollment for all reporting purposes and satisfies government requirements for F-1 and J-1 international students to maintain full-time enrollment.
- It is for students who are not enrolled in full-time coursework but are, nonetheless, working full time on their degree requirements (e.g., dissertation, thesis, degree recital, etc.).
- It does not include a relevant fee, though it does include other fees associated with full-time enrollment. The decision to utilize 997/897, and thus not charge fees, is made independently by each school and may occur for many reasons (for example, the student has not yet completed four full-years of doctoral enrollment, the student is enrolled full time during the summer, the student has been granted a one-time waiver of fees at the master's level, etc.).
- Students are registered with specific reference to a faculty advisor, who is ultimately responsible for monitoring their full-time effort.
- The student has either completed all requirements for the degree other than the thesis or is enrolled in final coursework in addition to the dissertation.
- The student has actively demonstrated full-time effort, whether through being physically located on campus or having completed the appropriate petitions to demonstrate full-time effort elsewhere in the U.S. (997A/897A) or abroad (997B/897B).
- Mandatory Health Fee is not required for students studying in absentia (e.g., 999A/899A or 997B/897B) and not enrolled in the University health insurance.
- International students utilizing the in absentia options must coordinate with ISO for immigration purposes.
- Students are eligible for federal loans.
- Students are eligible for University health insurance.

995/895
This status is utilized as follows:
- It is considered less than half-time enrollment for all reporting purposes.
- This category does not satisfy government requirements for F-1 and J-1 international students to maintain full-time enrollment and will require that students obtain advanced permission for a Reduced Course Load, if eligible.
- It is for students who are working less than half time on their degree requirements (e.g., dissertation, thesis, degree recital, etc.) or who are enrolled solely to satisfy the continuous enrollment requirement.
- It includes a relevant fee (often an enrollment continuation fee).
- Students are not necessarily registered with specific reference to a faculty advisor to monitor their effort. The choice to register with specific reference to a faculty advisor is made at the individual school level.
- Students are not eligible for federal loans.
- Students are not eligible for University health insurance.

990/890
This status is utilized as follows:
- It is considered full-time enrollment for all reporting purposes and satisfies government requirements for F-1 and J-1 international students to maintain full-time enrollment.
- It is for students who are in full-time residence during the summer for purposes such as completing a dissertation, performing research, completing a clinical rotation, etc.
- Note that this status is different than using 997/897 for full-time summer enrollment. If the 4th, 5th, and 6th bullets of the 997/897 definition can be satisfied, a school may wish to use that status instead, to allow the student to be eligible for federal loans.
- It does not include a relevant dissertation fee.
- Students are not necessarily registered with specific reference to a faculty advisor to monitor their effort. The choice to register with specific reference to a faculty advisor is made at the individual school level.
Refund of the Semester or Quarter Fee in the Final Semester

If the final corrected copy of the dissertation has been submitted and all degree requirements have been met midway through a semester or quarter, the student is eligible for a refund of the current fee for continuing enrollment according to the following schedule:

- 75% during the first four weeks of the semester or first three weeks of the quarter.
- 50% during the second four weeks of the semester or second three weeks of the quarter.
- 25% during the third four weeks of the semester or third three weeks of the quarter.

The form for refund is available in the Office of the University Dean of Graduate Studies for PhD students, and in the office of the associate dean of graduate studies for master’s students.

Conferral of Degrees

Degrees are awarded by the Board of Trustees at its regular meetings (October, March, and May) and conferred annually at the University’s Commencements. A degree candidate, upon meeting all degree requirements, will likely be awarded the degree at the next meeting of the Board of Trustees, but will receive the diploma by mail or at the following Commencement.

Transcripts

Transcripts of graduate work will be issued only at the written request of the student. Fees are determined at the school level. Transcript requests should be directed to the University registrar. (Students in the Eastman School of Music should request transcripts from the registrar, ESM.) The University reserves the right to withhold academic transcripts if an outstanding balance is owed the University.

Student Records

The University of Rochester complies fully with the provisions of the Family Educational Rights and Privacy Act (FERPA), 20 U.S.C. 1232g. Under FERPA students have, with certain limited exceptions, the right to inspect and review their educational records and to request the amendment of their records to ensure that they are not inaccurate, misleading, or otherwise in violation of the student’s privacy or other rights. Requests to inspect or review records should be addressed to the registrar, or to the appropriate administrator responsible for the record and will be honored within 45 days. Any student questioning the accuracy of any record may state his or her objection in writing to the University administrator responsible for the record, who will notify the student of his or her decision within 45 days of receiving the objection. Final review of any decision will be by the appropriate dean who, if requested by the student, will appoint a hearing committee of two faculty members and one staff member to investigate and make recommendations. Students concerned with the University’s compliance with FERPA have the right to file complaints with the U.S. Department of Education’s Family Compliance Office.

FERPA further requires, again with certain limited exceptions, that the student’s consent must be obtained before disclosing any personally identifiable information in the student’s education records. One such exception is disclosure to parents of dependent students. Another exception is disclosure to school officials with legitimate educational interests, on a “need-to-know” basis, as determined by the administrator responsible for the file. A “school official” includes anyone employed by the University in an administrative, supervisory, academic, research, or support staff position (including law enforcement unit personnel and health staff); any person or company acting on behalf of the University (such as an attorney, auditor, or collection agent); any member of the Board of Trustees or other governance/advisory body; and any student serving on an official committee, such as a disciplinary or grievance committee, or assisting another school official in performing his or her tasks. A school official has a legitimate educational interest if the official needs to review an education record in order to fulfill his or her professional responsibility. Other exceptions are described in the FERPA statute at 20 U.S.C. 1232g and regulations at 34 C.F.R. Part 99.

The University considers the following to be directory information: name, campus address, e-mail address, home address, telephone number, date and place of birth, academic fields of study, current enrollment (full or part time), dates of attendance, photographs, participation in recognized activities and sports, degrees and awards, weight and height of athletic team members, previous educational agencies or institutions attended, and other similar information. The University may publicize or respond to requests for such information at its discretion. However, the use of the records for commercial or political purposes is prohibited unless approved by the appropriate dean.

Currently enrolled students may request that directory information be withheld from disclosure by making a request, in writing, to the appropriate registrar. All requests made on or before September 30 will make it possible to have directory information omitted from printed directories. Requests made after this date should still be forwarded since they will prevent directory information from being released in the future. The University assumes that failure on the part of the student to specifically request the withholding of any directory information indicates approval of disclosure.

Policies Concerning the Doctor of Philosophy Degree

Administration of PhD Degree Programs

The degree of Doctor of Philosophy is awarded primarily for completion of scholarly work, research, or outstanding creative work satisfactorily described in a dissertation. It is assumed that recipients of this degree are well versed in the subject matter and research techniques of a specific discipline and have demonstrated breadth of interest and originality of outlook that indicate promise of success in future research and teaching. PhD degree programs offered by the University and registered with the State of New York are listed on page 20.
Established Interdisciplinary PhD Programs
For an established formalized interdisciplinary program (e.g., Visual and Cultural Studies, Neuroscience), a standing committee of faculty with formal affiliation to that program acts as a “department” and supervises the program requirements for its students.

Ad Hoc Joint PhD Degree Programs
To enable a student to pursue an individualized program of PhD study in more than one field, departments and programs authorized to offer work leading to the PhD degree may cooperate to offer a joint program. Joint work is supervised by an ad hoc committee convened for each student. Typically, the committee consists of two faculty from each discipline of the joint program, and a fifth member from outside the two programs of study who serves as the outside reader.

Each ad hoc committee is appointed by the University dean of graduate studies upon nomination by the Graduate Committee of the school(s) in which the departments/programs are located. A proposal outlining how degree requirements will be met, along with supporting documentation (including program of study, proposed plan for qualifying examination(s), up-to-date advising record, proposed thesis topic) must be submitted for approval before the student is admitted to candidacy.

University Administration of PhD Programs
Each school of the University has a Committee on Graduate Studies or the equivalent, consisting of representatives of departments and programs offering graduate degrees. The duties of these committees include reviewing the administrative practices of the departments/programs and the school with respect to requirements and training for the PhD, and advising the associate dean of graduate studies about the work toward the PhD degree.

The University has a Council on Graduate Studies composed of
- representatives of departments and programs in the University authorized to offer the PhD degree;
- the deans or associate deans for graduate studies of each school, or officer whose duties most closely correspond to this role;
- the provost of the University;
- the University dean of graduate studies, who serves as chair.

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, to recommend 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.

The vice provost and University dean of graduate studies is appointed by the trustees on recommendation of the provost and president. The vice provost and University dean of graduate studies
- is the University spokesperson in matters of graduate studies
- presides at meetings of the council and the steering committee
- may serve ex officio as a member of the committee established in any school for the conduct of the MA, the MS, or the PhD degree
- appoints (upon the advice of each associate dean of graduate studies) all committees for the final oral examination for the PhD degree
- the University dean of graduate studies or a delegate presides at all such examinations as chair.

Admission to PhD Programs
Policies on admission to graduate programs described earlier in these Regulations apply to PhD applicants. In addition, the following policies apply.

Faculty Eligibility to Enroll in PhD Programs
No person holding a full-time appointment as assistant professor or higher at the University of Rochester may be awarded an earned degree of Doctor of Philosophy from this University. An exception to this rule may occur only if the faculty member’s appointment is in a department other than the one in which the degree is earned and only if that appointment is warranted by the completion of a separate Doctor of Philosophy or other appropriate graduate degree. Faculty members holding the rank of instructor and non-faculty full-time employees of the University may pursue studies leading to the degree of Doctor of Philosophy only by special permission of the appropriate school’s Committee on Graduate Studies.

Transfer Credit
The associate dean of graduate studies may approve, for students who do not present the master’s degree, up to 30 credit hours of acceptable graduate work taken at this or another university toward the requirements for the doctoral degree. Work taken prior to matriculation in a graduate degree program is classified as possible transfer work. Limits on transfer credits are set at the program level. Credit hours may be accepted toward degree requirements if the subjects taken form an integral part of the proposed program of study and if taken within five years of the date of matriculation with a grade of B or higher as interpreted in this University. Requests for transfer credit must have the approval
of the associate dean of graduate studies. Similarly, permission to take work at another institution for transfer credit after matriculation in a graduate program must be approved in advance by the associate dean of graduate studies.

**Full-Time Residency Requirement**
A minimum of one year (two consecutive semesters, excluding summers) in residence while enrolled as a full-time student is required. Doctoral Dissertation ("999") may not be used to meet the one-year residency requirement. Further requirements may be completed by full-time residence either during the academic year or during the summer. Departmental/program requirements, however, may necessitate continuous residence until work for the degree is completed.

**Part-Time Study**
Ordinarily, graduate students may pursue work leading to the degree Doctor of Philosophy only if they are full-time students.

Permission to pursue a part-time plan of study is at the option of the department/program, subject to the approval of the Committee on Graduate Studies of that school. Part-time plans of study are subject to the following restrictions:

1. under no conditions will the residency requirement described above of one continuous academic year of full-time study be waived,
2. the minimum registration will be two courses, each carrying at least three credit hours, per calendar year (however, departments/programs may establish a higher minimum registration requirement), and
3. a student receiving grades lower than B (or S) in more than one-quarter of the courses for a given academic year may not be permitted to continue in the part-time program.

**Program of Study**
At least 90 credit hours of study beyond the bachelor’s degree or 60 hours beyond an acceptable master’s degree are required.

A tentative program of study leading to the degree of Doctor of Philosophy must be prepared by the student in consultation with his or her advisor. This should be done within two years after initial registration for doctoral studies. This program must include the following:

- A list of those courses for which the student must receive graduate credit. Other courses deemed desirable but not essential need not be listed.
- The specific foreign language(s), if any, in which the student must show competence (see below).
- The dissertation title if known, or area of study in which the dissertation is expected to be written.
- Name of the research director.

The program of study must be approved by the department chair/program director or a designated representative and then transmitted to the associate dean of graduate studies for approval. Changes in a student’s program are made by the same procedure.

The program of study will constitute the formal requirements that must be met by the student before completion of work for the degree.

Credit hours used for two graduate degrees cannot be used for another graduate degree at the University.

**Foreign Language Requirements**
Subject to the approval of the appropriate Committee on Graduate Studies, each department/program may designate its foreign language requirements for the PhD degree and specify the method of testing. Specific language requirements may be set for individual students by the department/program, subject to review by the associate dean of graduate studies. Each student should consult with his or her advisor concerning language requirements.

The basic language requirement, if any, must be met before the candidate may be permitted to take the qualifying examination.

**Time Limit for PhD**
All work for the PhD, including the final oral examination, must be completed within seven years from date of initial registration, except that a student who enters with a master’s degree or its equivalent for which the full 30 credit hours is accepted in the doctoral program must complete all work within six years from date of initial registration. All registration categories, including “985: Leave of Absence,” count towards the time limit.

Students who for good reasons have been unable to complete a program within the above stated limits may, upon recommendation of the faculty advisor and the department chair/program director, petition the associate dean (in the School of Nursing, the PhD subcommittee) for an extension of time. Such extensions, if granted, will be of limited duration and must be reapproved at least annually. Requests for extensions beyond 12 years must be approved by the University dean of graduate studies.

**Qualifying Examination**
All PhD programs must administer a qualifying examination as part of the PhD program requirements. The qualifying examination may be either written or oral or both, at the discretion of the department/program, and must be passed at least six months before the final examination may be taken. The Committee to conduct a qualifying examination will be appointed by the appropriate associate dean and will consist of at least three full-time faculty of professorial rank (four for the School of Medicine and Dentistry). Subject to the approval of the appropriate Committee on Graduate Studies, each department/program may designate whether or not it will include a member from another department/program on the committee. A vote to pass the candidate must be approved by a majority of the designated members of the committee. The votes of all committee members will be recorded. The office of the associate dean must be notified at least two weeks before a qualifying examination is to be held, and passage or failure must be reported within one month after the examination. After a failure, a second qualifying examination may be taken if in accordance with program policy. A third examination may be taken only upon the recommendation of the appropriate Committee on Graduate Studies and with the approval of the associate dean or equivalent. In the School of Nursing and the School of Medicine and Dentistry, a third examination will not be given.
Admission to Candidacy
When the associate dean of a school certifies that a student has passed the qualifying examinations and is recommended for candidacy, it is assumed that the student is a candidate for the PhD degree. Upon request, the University dean of graduate studies may issue a certificate attesting to this fact.

PhD Dissertation
Dissertation Advisory Committee
Ordinarily no later than when a student has been admitted to candidacy, the department chair or program director approves an advisory committee for the dissertation. The members should meet the requirements for membership in the final oral examination committee as described below. The composition of the dissertation advisory committee should be reported to the associate dean.

It is the responsibility of the dissertation advisory committee to advise the student concerning the proposed research and thesis, consult with him or her at appropriate stages in the research, and ordinarily to serve on the final oral examination committee.

Upon recommendation of the faculty of the student’s department/program and the associate dean of the school involved, the University dean of graduate studies may approve a person other than a full-time University of Rochester faculty member (e.g., a senior research associate or an adjunct or part-time faculty member) to serve as the student’s faculty advisor or research director. Approval must be obtained in writing.

In some circumstances, it may be appropriate to appoint to the advisory committee a person other than a member of the faculty of the University. With the approval of the associate dean and the University dean of graduate studies, this person may serve in place of or in addition to the outside department faculty member. Approval must be obtained in writing, based on a petition that includes a rationale for the request and a CV of the proposed nonstandard member.

Preparation of Dissertation
A dissertation is required of each candidate for the degree Doctor of Philosophy. The dissertation research must be conducted and the dissertation written under the supervision of the main advisor or research director, regardless of the student’s residency status.

The dissertation must be an original critical or synthetic treatment of a suitable subject, an original contribution to creative art, or a report on independent research formulated in a manner worthy of publication.

The dissertation must be written in English except where the subject matter demands otherwise and when requested by the department chair/program director and approved by the associate dean of graduate studies. Preparing Your Thesis: A Manual for Graduate Students must be followed to prepare the dissertation. The manual is available at the University Graduate Studies publications webpage (www.rochester.edu/gradstudies/publications.html).

Disclosure of Collaboration, Financial Support, and Prior Publication
In addition to other required elements delineated in the thesis manual, each dissertation must include a section entitled “Contributors and Funding Sources.” Placement of this section in the dissertation is described in the thesis manual.

In this section, all collaborations with others in carrying out the dissertation research must be clearly described, and the student’s independent contributions must be made clear. Similarly, the sources of financial support for the research must be listed.

Students who completed all work independently and/or without outside funding support should indicate this in the required section.

If content or results from the dissertation have been published in full or in part, the biographical sketch section of the dissertation must include bibliographic information about those publications. The dissertation will not be approved if it is subject to governmental or other restrictions that limit freedom of publication.

Final Oral Examination for the PhD Degree
Final Oral Examination Committee
The committee for the final examination for the PhD degree is appointed by the University dean of graduate studies on the advice of the appropriate associate dean of graduate studies. In most cases, the Final Oral Examination Committee includes the members of the original Dissertation Advisory Committee that supervised the thesis work. The committee for the final examination shall consist of:

- At least two current full-time tenure-track members with the rank of assistant professor or higher who hold their primary appointments in the department offering the degree program, or are among the core faculty defined for an interdisciplinary PhD program, in the role of “inside members” of the final oral examination committee. The dissertation advisor or supervisor may or may not hold a primary appointment in the department offering the candidate’s degree program but is considered to be inside that department or program for the purpose of committee membership.

- At least one current full-time faculty member at assistant professor rank or higher from outside the department offering the degree program in the role of “outside reader.” The holder of a secondary appointment in the department offering the candidate’s degree program may serve as the outside member, provided that his or her primary appointment is in another department. A committee made up of faculty members whose primary appointments are all in the same department will not be permitted. For interdisciplinary degree programs with faculty from several departments, the definitions of “inside” and “outside” for the final oral examination committee are set by the schools.

Exceptions to the above must be approved in writing, as described in the Dissertation Advisory Committee section above. The University dean of graduate studies may appoint no more than one nonstandard member, with vote, to any PhD final examination when requested by the program director or chair of the department concerned. As is the case for a nonstandard dissertation advisory committee member described earlier, the
Regulations and University Policies

The senior official for graduate studies in the school will identify a chair for each PhD oral defense within that school, using a process determined by the school, and will notify the selected individual, the candidate, and other committee members of the appointment. The student is responsible for providing the chair and all other committee members with copies of the dissertation identical to the version submitted for registration, for use at the oral defense.

The University dean of graduate studies grants final approval of all committee membership, including the appointed chair. This final committee approval is sent electronically to the entire committee and candidate shortly before the defense.

Registering the PhD Dissertation for the Final Oral Examination

The dissertation must be submitted to the office of the associate dean of graduate studies in the appropriate school to be processed and then delivered to the Office of the University Dean of Graduate Studies for registration. Dissertations may be submitted to the Office of University Graduate Studies for registration on any working day except for the week between Christmas and New Year’s Day and a period in late April (indicated on the PhD calendar distributed to all graduate studies officials in the schools).

The final oral examination cannot be held until at least five full working days have elapsed after the dissertation has been registered in the Office of the University Dean of Graduate Studies. The dissertation is not considered registered until it arrives in the Office of the University Dean of Graduate Studies. Therefore, the department and/or school deadline may be in advance of the University dean of graduate studies’ deadline. It is the student’s responsibility to plan accordingly. The student should check with the office of the associate dean of graduate studies for established deadlines.

It is the responsibility of the candidate to submit the completed dissertation to the office of the associate dean of graduate studies in the appropriate school by the school’s deadline. All typographical, spelling, and grammar errors must be corrected before the dissertation is submitted for registration. The dissertation submitted for registration must be bound in some manner and submitted with the required paperwork, including the appointment form with signatures of the members of the examining committee, and the date, time, and place of the examination.

The candidate must distribute copies of the dissertation to all members of the final examination committee before or at the same time the dissertation is registered, or the examination will be canceled. The candidate also must provide a copy of the same version to the appointed dissertation chair. Once the dissertation has been registered and copies distributed to committee members, no further changes can be distributed to committee members until after the final oral examination or the examination will be canceled.

Procedures for Final Oral Examination (PhD Dissertation Defense)

The final oral examination will be taken after completion of all other requirements for the degree but not earlier than six months after the qualifying examination.
The final oral examination for the Doctor of Philosophy degree must be taken at this University. The candidate, the advisor, and the appointed chair must be physically present. Participation of others via videoconference is permitted only if approved in advance by the advisor, the associate dean of graduate studies, the appointed examination chair, and the University dean of graduate studies.

The final oral examination will include the subject covered by the dissertation and the field in which the dissertation is written, with particular attention to recent and significant developments in that field. The purpose is to ascertain whether or not the candidate has proposed a significant thesis in the dissertation and whether or not he or she has defended the dissertation adequately by offering appropriate and effective arguments and by marshaling relevant and convincing evidence.

The presentation and defense of a significant dissertation is the capstone of the work for the PhD degree. All other work toward the degree is preliminary to this presentation. The final oral examination results not only in a judgment on a single work of scholarship but also implicitly on the quality of the whole graduate education of the candidate. Because the final oral examination has this wider meaning, it is important that the committee satisfy itself that a significant thesis has been successfully defended.

A vote of approval of the final oral examination committee must be unanimous, but in the case of a single dissenting vote the case will be presented for decision to the University Council on Graduate Studies. A candidate who fails the final examination shall be allowed one repeat examination, unless the examining committee recommends against it by a majority vote. Regulations for committee structure, timing of registration before defense, and so forth for a repeat examination are the same as those applied to the initial examination.

Submission of Final Dissertation
Following successful completion of the final oral examination, the candidate completes final revisions, secures approval of those revisions if so specified at the defense, uploads the final copy to the UMI/ProQuest website, and notifies the Office of the Dean of Graduate Studies that this process is complete. The candidate also should provide paper copies for use of the school or department if required.

Each PhD candidate also is required to submit a completed authorization form for inclusion of the dissertation in UR Research (the University’s digital research repository). Further instructions along with the authorization form will be emailed to the student on the next working day after the final oral examination.

Policies Concerning the MA and MS Degrees

Administration of Master of Arts and Master of Science Degrees
The master’s degree is awarded in arts, science, music, engineering, nursing, business, and education. Certain policies for MA and MS degree programs are common across programs and are detailed in this Bulletin. All administration of work for master’s degrees and recommendation of candidates for these degrees is vested in the associate dean of graduate studies and the Committee on Graduate Studies in each school.

Program of Study
Each full-time master’s student must submit a proposed program of study to the associate dean of graduate studies before the end of the second term. Each part-time master’s student must submit a proposed program of study upon the completion of 9 or 12 hours of graduate credit or as determined by the school.

The program of study, to be formulated with the assistance of the faculty advisor and approved by the associate dean, is expected to form a consistent plan of work pursued with a definite aim. Courses in another department closely related to, but outside the student’s major field of interest should not ordinarily exceed 12 hours of credit, and the candidate must have had thorough undergraduate preparation for such work. The program must include at least 20 hours taken at the University of Rochester as a matriculated student in a graduate degree program. Other than in approved combined undergraduate-graduate degree programs, no course completed before the candidate has received the bachelor’s degree may be included in the graduate program.

Two plans of study are available to students working for most MA and MS degrees; the principal difference between them is that under one plan (Plan A) a dissertation is required, while under the other (Plan B) a dissertation is not required, but in most departments a comprehensive examination must be passed.

Students may not switch from Plan A to Plan B (or vice versa) without written approval from the associate dean of graduate studies.

A minimum of 30 semester hours of correlated work of graduate character is required, at least 12 of which must be at the 400 level or higher, together with such other study as may be necessary to complete the student’s preparation in the chosen field and bring it to the required qualitative level. Minimum requirements are determined by the department/program concerned, with the approval of the associate dean of graduate studies.

Transfer Credit
Work taken prior to matriculation in a graduate degree program is classified as possible transfer work. Transfer credit may be accepted toward degree requirements if the subjects taken form an integral part of the student’s proposed program of study and if taken within five years of the date of matriculation with a grade of B or higher as interpreted in this University. Requests for transfer credit must have the approval of the faculty advisor and the associate dean of graduate studies.

The number and type of credit hours acceptable as transfer credit for work previously taken at the University of Rochester or another university is determined at the school level. Credit hours used for two graduate degrees cannot be used for another graduate degree at the University.
Permission to take work in another institution for transfer credit after matriculation in a graduate program must be approved in advance by the associate dean of graduate studies.

**Part-Time Study**
Students admitted to master’s degree programs on a part-time basis must follow continuous programs of study. The associate dean of graduate studies may disapprove a part-time program if the nature of the proposed study makes such a program inadvisable.

**Time Limit for MS or MA Degree**
A candidate must complete all the requirements for the master’s degree within five years (seven years at the Simon School) from the time of initial registration for graduate study, and must maintain continuous enrollment for each term after matriculation. Except in the School of Nursing, the five-year maximum period will be reduced at the rate of one term for each unit of three hours taken prior to matriculation at this University and applied toward the requirements for the master’s degree. All registration categories including “Leave of Absence” count towards the time limit.

Students who for good reason have been unable to complete a program within five years may, upon recommendation by the faculty advisor and department chair, petition the associate dean of graduate studies for an extension of time. Such extension, if granted, will be of limited duration.

**Requirements for the MA or MS Degree under Plan A**
Plan A requires the writing of a dissertation and the passing of an oral examination on the dissertation.

**Program of Study for Plan A**
A dissertation is required in each program for the Master of Arts or Master of Science degree under Plan A. The dissertation and the research upon which it is based represent a minimum of 6 and ordinarily a maximum of 12 credit hours in reading or research. In certain cases, and with the prior approval of the associate dean of graduate studies, the credit for dissertation research may exceed 12 hours.

**Preparation of MS or MA Dissertation**
The dissertation must show independent work based in part upon original material. It must present evidence that the candidate possesses ability to plan study over a prolonged period and to present in an orderly fashion the results of this study. The dissertation should display the student’s thorough acquaintance with the literature of a limited field.

“Preparing Your Thesis: A Manual for Graduate Students” is also used to prepare master’s dissertations. Copies of the booklet are available from the office of the associate dean of graduate studies or on the University’s website: www.rochester.edu/theses.

**Registration of MS or MA Dissertation**
The dissertation must be registered with the office of the associate dean of graduate studies and copies given to the members of the examining committee at least one week prior to the oral examination (two weeks in the School of Medicine and Dentistry). The final examination must be held prior to the date set by the associate dean of graduate studies.

**Submission of Copies**
The school or program may require printed and/or electronic copies of the final thesis as a condition of completion of the degree program.

**Final Oral Examination for MS or MA under Plan A**
Each candidate must pass a final oral examination before a committee of at least three members of the faculty appointed by the associate dean of graduate studies (four for the School of Medicine and Dentistry). One member will be from a department other than that in which the student has done the major portion of the work. No candidate may appear for the final examination until permission is received from the faculty advisor to proceed. The examination will not be given until at least a week has elapsed after registration of the dissertation. The final examination may be preceded by other examinations, oral or written, as designated by the department/program or school concerned.

**Re-Examination**
A student who fails the final oral examination may request re-examination not less than four months later. No student will be allowed to take the examination a third time without a recommendation from the department/program in which the major work was done and the approval of the Committee on Graduate Studies of the school.

**Requirements for the MA or MS Degree under Plan B**

**Program of Study for Plan B**
The degrees Master of Arts and Master of Science under Plan B are awarded for successful completion of at least 30 hours of graduate credit, or more if required in the student’s program of study. At least 18 hours of the coursework must be in the student’s principal department, except for interdisciplinary programs which have been approved by the relevant school’s Committee on Graduate Studies, and at least 12 of the 18 hours in the approved program must be in courses numbered 400 or over. Individual schools may set higher requirements.

If the department requires a course of directed individual study leading to the writing of a master’s essay, this course is in addition to the minimum requirement of courses numbered 400 or over. It may carry up to four hours of credit.

Ordinarily, research credit is not part of a Plan B master’s program; but, with the approval of the associate dean of graduate studies, up to six hours of research credit may be granted. Total credit for research, reading, and the master’s essay may not exceed six hours. Credit hours used for two graduate degrees cannot be used for another graduate degree at this University.

**Directed Study for the Master’s Essay**
The master’s essay, required by some departments/programs, must present evidence of the student’s ability to present a well-organized report on a topic of significance in the field. The writing of this essay is under the supervision of one member of the
student's principal department/program, and must be approved by one additional member designated by the chair of the department or by the program director for interdisciplinary programs.

**Comprehensive Examination**

Most Plan B programs of study require a comprehensive examination in the field of specialization. It may be written, oral, or both, and is conducted by at least two faculty members.

Students failing the general examination may be allowed to take another examination during the following semester but not later than one year after the original examination. More than one repetition of the examination is not permitted.

**Standards of Conduct for Graduate Students**

**The University as a Community**

The University of Rochester is dedicated to providing educational opportunities for its students and to transmitting and advancing knowledge. The tradition of the University as a sanctuary of academic freedom and a center of informed discussion is an honored one. It is committed to the protection of intellectual freedoms and rights: of professors to teach; of scholars to study; of students to learn; and of all to express their views.

The University of Rochester is pluralistic and values diversity. Members of the community must respect the rights of the individuals and diverse groups that constitute the University. It is essential that the University remain supportive of democratic and lawful procedure, dedicated to a rational approach to resolving disagreement, and free from discrimination, violence, threats, and intimidation.

Students are expected to abide by the rules of the University and to conduct themselves in accordance with accepted standards of good citizenship, honesty, and propriety; and with proper regard for the rights of others. Students must also obey federal, state, and local laws as would any good citizen. Furthermore, their responsibilities as students, scholars, researchers, and in many cases teachers and emerging professionals, often make special demands for the highest ethical standards.

The maintenance of harmonious community standards requires that behavior that interferes with or threatens the welfare of others or the University community be prevented. Ignorance of these standards will not be considered a valid excuse or defense. Student participation in any unlawful or other potentially serious violations of University policy may lead to suspension or expulsion from the University.

**Basic Rights and Expectations of Students Accused of Misconduct**

Students who choose to attend the University of Rochester should understand that they have certain fundamental rights and that they have committed themselves to adhering to academic and social standards essential to the well-being of the community. Any student charged with misconduct will be treated in accordance with the basic standards of fundamental fairness, which include timely notification of charges, fair and impartial hearings, and the right of appeal. Students are expected to respond in a timely fashion to any and all written or verbal communication, including but not limited to voice mail, electronic mail, letters, and other forms of correspondence. Failure to check for these forms of communication does not relieve students of their responsibility to reply.

A significant goal of campus judiciary proceedings is to promote the welfare of the student, making the student aware of community standards, and discouraging the student from engaging in behavior that negatively impacts the University community. Another significant goal is to protect the University community’s collective interests and deter potential offenders.

There are important technical differences between campus and criminal judicial proceedings. The University of Rochester, in contrast to the state, does not have fully empowered police or investigative units, does not have legal counsel in preparing or presenting cases, and has limited capabilities in comparison with the state to subpoena witnesses or punish them for perjury. It would not be in either the University’s or the student’s best interest to attempt to incorporate these features in the campus judicial system. Indeed, a formal and adversarial procedure might have the effect of suppressing information that, in the interest of a student’s long-term development, is best to bring out.

**University Procedures and the Public Law**

The University is not a sanctuary from public law and does not promote or condone unlawful behavior. The University cooperates with law enforcement authorities in a manner consistent with its legal duties and the interests of the University community.

Students under prosecution for violation of public law may also be subject to University judicial proceedings, which are independent of those under public law. The University may take prompt action under its own procedures regardless of whether the public officials have disposed of the case or what disposition they make.

Students may be subject to the University conduct system for allegations of unlawful conduct that occur on University property or that occur off campus if such off-campus conduct is associated with a University activity or raises considerable concerns that the individual or group poses a threat to the safety or welfare of the University community.

**Jurisdiction and Responsibility for Academic and Nonacademic Misconduct**

There is not always a clear distinction between academic and nonacademic misconduct. The fundamental criterion for deciding whether a matter is academic or nonacademic is whether the student was acting in a scholarly or professional capacity. When the incident involves a student acting in his or her role as a student, teaching assistant, or expert in his or her discipline, then the matter is an academic matter. When the incident involves a student acting as an individual independent of these roles, then the matter is nonacademic.

A complaint against a graduate student should be forwarded to the appropriate associate dean of graduate studies within that student’s school, who determines whether the complaint should be treated as an academic or a nonacademic matter. Academic misconduct matters will be referred to the appropriate associate dean, as explained on pages 36–38. Nonacademic
Academic Misconduct

Instructor records evidence of possible misconduct according to school procedure, informs student(s), and reports incident to graduate dean or designee.

Graduate dean or designee receives report of potential academic misconduct, reviews material, and/or meets with those involved.

Case dismissed if, after reviewing all relevant information, graduate dean or designee determines that academic misconduct did not occur.

Graduate dean or designee determines matter should be treated as academic misconduct and does not qualify for administrative resolution.

If alleged academic misconduct involves sponsored research, threatens the integrity of the scientific method, or compromises the creation of new knowledge, the matter will be referred to the relevant University body handling scientific or research misconduct and will follow procedures as specified in the Faculty Handbook.

Schools may allow administrative resolution by graduate dean or designee for first offenses, if student and reporting faculty agree on the facts of the incident and the proposed penalty. Decision and penalty are not final until approved by graduate dean or designee. Graduate dean or designee maintains records of all incidents resolved in this manner.

Refers charges to student’s department or standing conduct panel in the school.

Panel conducts hearing, makes findings, presents supporting documents and recommendation to the graduate dean or designee.

Graduate dean or designee submits them along with his or her recommendation to the University dean of graduate studies.

University dean of graduate studies issues decision and, if appropriate, a sanction.

Student/Victim appeals decision to the provost.

Decision accepted.

Decision modified.

Decision upheld.
matters will be referred to the judicial officer, who will consult with the associate dean before going forward with any complaint against a graduate student that he or she receives from any source other than the associate dean.

The available hearing procedures are not intended to be mutually exclusive; it is possible that a student could be subject to both academic and nonacademic discipline for the same misconduct.

Definition of Academic Misconduct
The fundamental criterion for deciding whether a matter is academic or nonacademic is whether the student was acting in a scholarly or professional capacity. When misconduct involves a student acting in his or her role as a student, including activities as a research or teaching assistant, or expert in his or her discipline, then the matter is an academic matter.

Academic Honesty Policy
The University of Rochester considers academic honesty to be a central responsibility of all students. Suspected infractions of University policies will be treated with the utmost seriousness. Suspected graduate academic misconduct will be reported to the department chair and associate dean of graduate studies.

Plagiarism is a pervasive form of academic dishonesty. This is the use, whether deliberate or unintentional, of an idea or phrase from another source without proper acknowledgment of that source. The risk of plagiarism can be avoided in written work by clearly indicating, either in footnotes or in the paper itself, the source of any other major or unique idea which the student could not or did not arrive at on his or her own. Sources must be given regardless of whether the material is quoted directly or paraphrased. Another form of plagiarism is copying or obtaining information from another student. Submission of written work, such as laboratory reports, computer programs, or papers, which has been copied from the work of other students, with or without their knowledge and consent, is also plagiarism. In brief, any act that represents someone else’s work as one’s own is an academically dishonest act.

There are several other forms of academic dishonesty including, for example, obtaining an examination prior to its administration or using unauthorized aids during an examination. It is also academically dishonest to assist someone else in an act of academic dishonesty. Fraud, misrepresentation, forgery, falsifying documents, records, or identification cards, and fabricating or altering research data are other forms of academic misconduct.

A student remains responsible for the academic honesty of work submitted to the University as part of the requirements for the completion of a degree (or any other coursework taken at the University) even after the work is accepted, the degree is granted, or the student is no longer matriculated at the University of Rochester.

Ignorance of these standards is not considered a valid excuse or defense.

Judicial Process for Academic Misconduct
The events and documents indicating suspected misconduct and the information provided by involved parties during the investigation should be documented in full. Schools may develop forms for this purpose.

Each department, interdisciplinary program, or school will have a written policy on academic misconduct on file with the graduate dean or designee and a designated group to hear the charge. This may be a standing panel within the school or a department panel that consists of (1) the usual faculty group that deals with graduate student business, (2) the entire faculty of the department, or (3) a committee appointed specifically for the purpose of hearing the academic misconduct charge. A school’s written policy may call for graduate student representation on the panel.

The process of review of academic misconduct is shown on page 37. Some academic misconduct incidents may be handled administratively by the graduate dean or designee. These are limited to first offenses in which the student(s) alleged to have committed the offense, the student victims if any, and the faculty member(s) reporting the incident agree on the events that occurred, the nature and seriousness of the misconduct, and the proposed penalty. Documentation is submitted to the graduate dean or designee, who may approve the proposed penalty and communicate this to the parties involved or may opt to refer the case to the panel. In handling cases administratively without panel involvement, graduate deans or designees must satisfy themselves that the student admitted guilt without coercion and that the proposed penalty is appropriate to the offense and comparable to other penalties for similar offenses.

Nonacademic Misconduct
Students should conduct themselves in a way that reflects respect for the standards of our community; this includes obeying federal, state, and local laws as well as the guidelines listed below. Not knowing and understanding these standards is not a defense or valid excuse.

Resource for Concerns about a Student’s Conduct
Any member of the University community, including faculty, staff, and graduate and undergraduate students, may use the University’s CARE Network (www.rochester.edu/care) to identify a student in need of any form of support. The CARE team will mount an inclusive, suitable response, often engaging the individual(s) most closely connected with the student in need. Connecting with students in distress can take on many forms (emails, phone calls, check ins from a resident assistant, communication with instructors, etc.). The appropriateness of each contact method is addressed by the CARE team and is determined on a case-by-case basis. Questions or concerns may be directed to the assistant director for student support services in the Office of the Dean of Students at (585) 273-2568 or erin.halligan@rochester.edu.

Review of Cases of Alleged Nonacademic Misconduct
For cases of nonacademic misconduct, the University of Rochester Conduct System applies to both undergraduate and graduate students. The same system of review and resolution applies to undergraduate and graduate students across the University.

Authority to hold students (which the University considers to be any person or group who is or was in attendance during
Standards of Student Conduct

The activities that may constitute misconduct and the process for reporting, review, and resolution of allegations of nonacademic misconduct are described in detail in the Standards of Student Conduct, found at www.rochester.edu/college/odos/assets/pdf/standardsofstudentconduct20132014.pdf.

This document, updated annually, includes all policies and procedures related to nonacademic misconduct, ranging from public safety concerns to misuse of University resources. Selected topics are highlighted here.

The following statement of principles from the Standards of Student Conduct applies to all students within the University community.

Statement of Communal Principles

Fairness
The principles of fairness and openness are fundamental to the operations of this community—its processes for decision making, problem solving, and doing the work of the institution. Every person has the right to, and should expect, fair treatment according to openly stated and clearly articulated expectations, policies, and procedures and in accordance with the fundamental rights and privileges of a free society. Every person is encouraged in parallel ways to use fair and open methods of communication and action, including wherever possible, those provided by existing institutional channels, in voicing concerns and seeking solutions to problems.

Freedom
The freedom of all people in a community of learning to ask questions and to seek answers is essential and actively encouraged. Each person has the right to learn, teach, and work—to express themselves through their ideas and activities—without threat to his or her education or career progress or to that of others. Freedom of expression of ideas and action is not to be limited by acts of intimidation, political or ideological oppression, abuse of authority, or threat of physical harm and well-being.

Honesty
Honesty and personal integrity are fundamental to all assumptions of participation in a community dedicated to the advancement of knowledge. Honesty advances our efforts as well as strengthens the interrelationships on which community is built. On the other hand, dishonesty undermines the search for truth and undermines the bonds between the persons who live, study, and work here. It further damages community by wasting the energy and educational opportunities of all involved.

Inclusion
Our community welcomes, encourages, and supports individuals who desire to contribute to and benefit from the institution’s missions. Members of the University’s community come from different geographical areas, represent differences in ethnicities, religious beliefs, values, and points of view; they may be physically different, have different intellectual interests, or have different abilities. We not only welcome such differences in members of our community, but we also actively seek to include them in all aspects of the institution’s operations.

Responsibility
Freedom and responsibility are two sides of the same coin. To uphold this kind of freedom of expression and action in the public arena, each person has the responsibility to own his or her ideas and actions as well as express them in ways that do not limit or threaten others’ freedom to learn, teach, and work. This means that ideas and actions are neither anonymous nor isolated. To act or express one’s ideas openly and in a responsible manner enhances the learning and growth of all. On the other hand, to act or express one’s ideas in an irresponsible manner impinges on others’ rights and freedom to learn and grow.
Policies on Certain Forms of Nonacademic Misconduct

Affirmative Action, Equal Opportunity, and Antidiscrimination Statements

An Inclusive Community
The University of Rochester envisions itself as a community that welcomes, encourages, and supports individuals who desire to contribute to and benefit from the institution’s missions of teaching, research, patient care, performance, and community service. In a pluralistic culture of faculty, staff, and trainees, members of the University’s community come from different geographical areas and represent differences in ethnicities, religious beliefs, values, and points of view; they may be physically different, have different intellectual interests, or have different abilities. The success of the University of Rochester depends on an environment that fosters vigorous thought and intellectual creativity, one in which diverse ideas can be expressed and discussed by all in its community. To fulfill its missions and prepare future leaders to succeed in an equally wide-ranging environment, the University actively seeks to recruit and include diverse individuals in all aspects of the institution’s operations.

Affirmative Action and Equal Employment Opportunity Statement
In keeping with its long-standing traditions and policies, the University of Rochester affirms its commitment to nondiscrimination and equal opportunity in admissions, employment, access to and treatment in University programs and activities, in accordance with federal, state, and local laws and regulations. To help establish and perpetuate an inclusive and open environment, all members of the University community are expected to support the University’s Equal Opportunity Statement:

The University of Rochester values diversity and is committed to the equal opportunity for all persons regardless of age, color, disability, ethnicity, gender identity or expression, genetic information, marital status, military/veteran status, national origin, race, religion/creed, sex, sexual orientation or any other status protected by law. The University complies with all applicable nondiscrimination laws in the administration of its policies, admissions, employment, and access to and treatment in University programs and activities.

The University maintains a policy regarding Affirmative Action, pursuant to its obligations as a federal contractor, which can be found at www.rochester.edu/working/hr/policies/pdfpolicies/102.pdf.

Disability Accommodation
The University of Rochester is committed to providing equal educational and employment opportunities for qualified individuals with disabilities, in accordance with state and federal laws and regulations. Further, the University is committed to maintaining an inclusive environment for individuals with disabilities. The University’s affirmative action policy with respect to individuals with disabilities (including disabled veterans) can be found at www.rochester.edu/working/hr/policies/pdfpolicies/106.pdf.

Sex-Based Discrimination and Harassment
The University prohibits sex-based harassment and discrimination, including sexual assault, dating violence, domestic violence, and stalking, in accordance with Title IX of the Education Amendments Act of 1972 and other applicable federal and local laws.

The University’s Discrimination and Harassment Policy (referenced above) explains the process for addressing complaints against faculty, staff, and visitors. The Student Sexual Misconduct Policy (found at www.rochester.edu/college/odos/conduct/) explains the process for bringing a complaint of sex-based harassment and discrimination against students.

Morgan Levy serves as the University’s Title IX Coordinator and can be reached for questions or concerns by phone at (585) 275-7814, by email at morgan.levy@rochester.edu, or in person at her office in 268 Wallis Hall.

Conduct Records
Student records, including files from disciplinary cases maintained by the University, are treated with appropriate confidentiality, in accordance with the University policy on student records and relevant legal standards. Academic transcripts issued during periods of suspension or expulsion will be accompanied by a letter from the registrar indicating that the student is currently suspended or expelled from the University for conduct reasons. University staff who have knowledge of action taken against a student for misconduct may on occasion be asked to respond to inquiries regarding the student’s involvement in disciplinary action. In accordance with the confidentiality of such records, the University officer may only reveal such information with the authorization of the student, except when required by law or when the University officer perceives a significant risk to the safety or well-being of that student or others. Conduct files are normally destroyed seven years after the student’s separation from the University. However, certain University officials may indefinitely retain records in other appropriate circumstances.
Committee on Graduate Studies

The Committee on Graduate Studies shall consist of the following members: the delegate of the Dean of the Faculty who shall be chair; the Dean of the Faculty and the University Dean of Graduate Studies, both ex-officio; the Director of Graduate Studies for each program that offers a PhD or master’s degree; and four graduate students (one from each of the four major disciplinary domains: the humanities, the social sciences, the natural sciences, and engineering). Election of the graduate student members shall be by the vote of graduate students.

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. The terms of the student representatives shall be one year. 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.

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 hours of graduate credit. 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. A minimum of 12 of the 18 credit hours of formal coursework must be at the 400 level. A limit of 12 credit hours at the 200–300 level can be approved on the Program of Study. 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 hours of graduate credit, 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, and at least 18 hours in the approved master’s program must be in formal courses numbered 400 or higher. A limit of 12 credit hours at the 200–300 level can be approved on the Program of Study. If the department requires a master's essay, this course is in addition to the minimum requirement of 18 hours of courses numbered 400 or higher, and it 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.

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 the instructor assigns. 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 students.
School of Arts & Sciences

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Debra Haring
Assistant Dean for Grants and Contracts

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Professor of Physics

Honey Meconi, PhD (Harvard)  
Sue B. Anthony Professor of Gender and Women's Studies, Professor of Music, and Professor of Musicology in the Eastman School of Music

Ralf Meerbote, PhD (Harvard)  
Professor Emeritus of Philosophy

Adrian C. Melissinos, PhD (MIT)  
Professor of Physics

William H. Merigan, PhD (Maryland)  
Professor of Ophthalmology, of Environmental Medicine, of Brain and Cognitive Sciences, and in the Center for Visual Science

David D. Meyerhofer, PhD (Princeton)  
Professor of Mechanical Engineering and of Physics; Director of the Experimental Division and Senior Scientist in the Laboratory for Laser Energetics

John Michael, PhD (Johns Hopkins)  
Professor of English and in Visual and Cultural Studies

Archibald Miller, MFA (Cranbrook Academy)  
Professor Emeritus of Art

Dean A. Miller, PhD (Rutgers)  
Professor Emeritus of History

René Millon, PhD (Columbia)  
Professor Emeritus of Anthropology

Gautam Mitra, PhD (Johns Hopkins)  
Professor of Geology

Deborah Modrak, PhD (Chicago)  
Professor of Philosophy

Jesse T. Moore, PhD (Pennsylvania State)  
Professor Emeritus of History

Demetrius Moutsos, PhD (Chicago)  
Professor Emeritus of Linguistics

William B. Muchmore, PhD (Washington)  
Professor Emeritus of Biology

Govind S. Mudholkar, PhD (North Carolina)  
Professor of Statistics and of Biostatistics

John S. Mucender, PhD (Stanford)  
Professor Emeritus of Chemistry

Paul Muller-Ortega, PhD (California, Santa Barbara)  
Professor of Religion

Raymond Murphy, PhD (Northwestern)  
Professor Emeritus of Sociology

Joseph Neisendorfer, PhD (Princeton)  
Professor Emeritus of Mathematics

Richard G. Niemi, PhD (Michigan)  
Don Alonzo Watson Professor of Political Science

Ernest Nordeen, PhD (California, Irvine)  
Professor of Brain and Cognitive Sciences, of Psychology, and of Neurobiology and Anatomy

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

Dennis O'Brien, PhD (Chicago)  
Professor Emeritus of Philosophy

Susumu Okubo, PhD (Chicago)  
Professor Emeritus of Physics

Joanna Olmsted, PhD (Rochester)  
Professor Emeritus of Physics

H. Allen Orr, PhD (Chicago)  
University Professor, Shirley Cox Kearns Professor, and 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

Gary D. Paige, MD (Chicago)  
Kilian J. and Caroline F. Schmitt Professor of Neurobiology and Anatomy, Professor of Neurology, of Ophthalmology, of Biomedical Engineering, of Surgery, of Brain and Cognitive Sciences, and in the Center for Visual Science

Kathleen Parthé, PhD (Cornell)  
Professor of Russian
Tatiana Pasternak, PhD (Copenhagen)
Professor of Neurobiology and Anatomy, of Brain and Cognitive Sciences, and in the Center for Visual Science

Russel A. Peck, PhD (Indiana)
John H. Deane Professor of Rhetoric and English Literature and Professor of English

Charles E. Phelps, PhD (Chicago)
University Professor, Professor of Political Science, of Economics, and of Community and Preventive Medicine

Judith Pipher, PhD (Cornell)
Professor Emeritus of Astronomy

Arnold Pizer, PhD (Yale)
Professor Emeritus of Mathematics

*Terry Platt, PhD (Harvard)
Professor of Biology

David Pollack, PhD (California, Berkeley)
Professor of Japanese and Chinese

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)
Professor of Biology

Oleg Prezhdo, PhD (Texas)
Professor of Chemistry

David Prill, PhD (Princeton)
Professor Emeritus of Mathematics

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

Ralph A. Raimi, PhD (Michigan)
Professor Emeritus of Mathematics

Sarada G. Rajcev, PhD (Syracuse)
Professor of Physics and of Mathematics

Jarold Ramsey, PhD (Washington)
Professor Emeritus of English

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

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

S. Peter Regenstreif, PhD (Cornell)
Professor Emeritus of Political Science and of Canadian Studies

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

Nathan Rosen, PhD (Columbia)
Professor Emeritus of Russian Literature

Lewis Rothberg, PhD (Harvard)
Professor of Chemistry, of Chemical Engineering, and of Physics

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

Joan Rubin, PhD (Yale)
Dexter Perkins Professor of History

Richard Ryan, PhD (Rochester)
Professor of Psychology and of Education

Remy G. Saisselin, PhD (Wisconsin)
Professor Emeritus of Fine Arts and of French Literature

Walter H. Sangree, PhD (Chicago)
Professor Emeritus of Anthropology

Stanley Sapon, PhD (Columbia)
Professor Emeritus of Psycholinguistics

William H. Saunders, Jr., PhD (Northwestern)
Professor Emeritus of Chemistry

Malcolm P. Savenoff, PhD (Princeton)
Professor Emeritus of Astronomy

Claudia Schaefer, PhD (Washington)
Russell Rhines Professor and Professor of Spanish

Marc Schieber, MD (Washington University)
Professor of Neurology, of Neurobiology and Anatomy, of Physical Medicine and Rehabilitation, of Brain and Cognitive Sciences, and in the Center for Visual Science

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

Jeremy S. Schwartzbaum, PhD (Stanford)
Professor Emeritus of Psychology

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

Joel Seligman, JD (Harvard)
Professor of Political Science and Professor of Business Administration in the William E. Simon Graduate School of Business Administration

Yonathan Shapir, PhD (Tel Aviv)
Professor of Physics, of Chemical Engineering, and of Mathematics

Stewart Sharpless, PhD (Chicago)
Professor Emeritus of Astronomy

Albert Simon, PhD (Rochester)
Professor Emeritus of Mechanical Engineering and of Physics and Senior Scientist in the Laboratory for Laser Energetics

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

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

Thomas Spence Smith, PhD (Chicago)
Professor of Sociology

Roman I. Sobolewski, PhD (Polish Academy of Sciences)
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Norman Stein, PhD (Cornell)
Professor Emeritus of Mathematics

Dorothy M. Stone, PhD (Bryn Mawr)
Professor Emeritus of Mathematics

Randall Stone, PhD (Harvard)
Professor of Political Science

Carlos R. Stroud, Jr., PhD (Harvard)
Professor of Optics and of Physics

Robert G. Sutton, PhD (Johns Hopkins)
Professor Emeritus of Geology

Ching W. Tang, PhD (Cornell)
Doris Johns Cherry Professor and Professor of Chemical Engineering, of Chemistry, and of Physics

Michael K. Tanenhaus, PhD (Columbia)
Beverly Petterson Bishop and Charles W. Bishop Professor, Professor of Brain and Cognitive Sciences, of Psychology, and of Linguistics

John Tarduno, PhD (Stanford)
Professor of Geophysics and of Physics and Astronomy
Stephen Teitel, PhD (Cornell)  
Professor of Physics

Robert ter Horst, PhD (Johns Hopkins)  
Professor Emeritus of Spanish

Dinesh Thakur, PhD (Harvard)  
Professor of Mathematics

John H. Thomas, PhD (Purdue)  
Professor of Mechanical and Aerospace Sciences and of Astronomy

William Thomson, PhD (Stanford)  
Elmer B. Millman Professor of Economics and Professor of Economics

Edward Thorndike, PhD (Harvard)  
Professor of Physics

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

Douglas Turner, PhD (Columbia)  
Professor of Chemistry and of Pediatrics

Hugh Van Horn, PhD (Cornell)  
Professor Emeritus of Physics and Astronomy

Michael Venezia, MFA (Michigan)  
Professor Emeritus of Art

David A. Walsh, PhD (Minnesota)  
Professor of Art History and of History

John J. Waters, PhD (Columbia)  
Professor Emeritus of History

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

Stewart Weaver, PhD (Stanford)  
Professor of History

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

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

Ladd Wheeler, PhD (Minnesota)  
Professor Emeritus of Psychology

Edward Wierenga, PhD (Massachusetts)  
Professor of Religion and of Philosophy

David Williams, PhD (California, San Diego)  
William G. Allyn Professor of Medical Optics and Professor of Brain and Cognitive Sciences, of Optics, of Psychology, in the Center for Visual Science, of Ophthalmology, and of Biomedical Engineering; Director of the Center for Visual Science, Dean for Research in Arts, Sciences & Engineering

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

Emil Wolf, DSc (Edinburgh)  
Wilson Professor of Optical Physics and Professor of Optics

Frank Wolfs, PhD (Chicago)  
Professor of Physics

Yongsung Chang, PhD (Rochester)  
Professor of Economics

Mary Young, PhD (Cornell)  
Professor Emeritus of History

Melvin Zax, PhD (Tennessee)  
Professor Emeritus of Psychology

Jianhui Zhong, PhD (Brown)  
Professor of Imaging Sciences, of Biomedical Engineering, and of Physics

Miron Zuckerman, PhD (Harvard)  
Professor of Psychology

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Matthew BaileyShea, PhD (Yale)  
Associate Professor of Music in the College and of Musicology in the Eastman School of Music

Paulo Barelli, PhD (Columbia)  
Associate Professor of Economics

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

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Cheeptip Benyajati, PhD (Princeton)  
Associate Professor of Biology

Joanne Bernardi, PhD (Columbia)  
Associate Professor of Japanese

Xin Bi, PhD (Johns Hopkins)  
Associate Professor of Biology

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

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

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

Elizabeth Cohen, MFA (Rhode Island School of Design)  
Associate Professor of Art

Peter Como, PhD (Delaware)  
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Richard Dees, PhD (Michigan)  
Associate Professor of Philosophy and of Neurology, of Pediatrics, and of Medical Humanities

Ayala Emmett, PhD (Rochester)  
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Mark Fey, PhD (California Institute of Technology)  
Associate Professor of Political Science

William FitzPatrick, PhD (California, Los Angeles)  
Associate Professor of Philosophy

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Associate Professor of Mathematics

John Givens, PhD (Washington)  
Associate Professor of Classics

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

George Grella, PhD (Kansas)  
Associate Professor of English and of Film Studies
Jennifer Grotz, PhD (Houston)
  Associate Professor of English
Rachel Haidu, PhD (Columbia)
  Associate Professor of Art History and of Visual and Cultural Studies
Gretchen Helmke, PhD (Chicago)
  Associate Professor of Political Science
June Hwang, PhD (California, Berkeley)
  Associate Professor of History
Larry E. Hudson, PhD (Keele)
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T. Florian Jaeger, PhD (Stanford)
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  and in the Center for Visual Science
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  of Biology
Naomi Jochnowitz, PhD (Harvard)
  Associate Professor of Mathematics
Andrew Jordan, PhD (California, Santa Barbara)
  Associate Professor of Physics
Barbara Jordan, MA (Boston)
  Associate Professor of Physics
Anastassios Kalandrakis, PhD (California, Los Angeles)
  Associate Professor of Political Science
Rosemary Kegl, PhD (Cornell)
  Associate Professor of English
Cilas Kemedjio, PhD (Ohio State)
  Associate Professor of French
John Kessler, PhD (California, Irvine)
  Associate Professor of Earth and Environmental Sciences
David Lambert, PhD (Arizona)
  Associate Professor of Biology
Matthew Lenoe, PhD (Chicago)
  Associate Professor of History
Eric Mamajek, PhD (Arizona)
  Associate Professor of Physics and Astronomy
Katherine Mannheimer, PhD (Yale)
  Associate Professor of English
David McCamant, PhD (California, Berkeley)
  Associate Professor of Chemistry
Joyce McDonough, PhD (Massachusetts)
  Associate Professor of Linguistics and of Brain and Cognitive Sciences
Ernestine McHugh, PhD (California, San Diego)
  Associate Professor of Anthropology and Religion in the Eastman School of
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Bonnie Meguid, PhD (Harvard)
  Associate Professor of Political Science
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  and of Brain and Cognitive Sciences
Alyssa Ney, PhD (Brown)
  Associate Professor of Philosophy
Bradley Nilsson, PhD (Wisconsin, Madison)
  Associate Professor of Chemistry
Thomas O’Connor, PhD (Virginia)
  Associate Professor of Psychiatry and of Psychology
William E. O’Neill, PhD (SUNY, Stony Brook)
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  Sciences
Jonathan Pakianathan, PhD (Princeton)
  Associate Professor of Mathematics
Donna R. Palumbo, PhD (New School University)
  Associate Professor of Neurology, of Pediatrics and of Psychology
Jean Pedersen, PhD (Chicago)
  Associate Professor of History in the Eastman School of Music and of History
Ryan Prendergast, PhD (Emory)
  Associate Professor of Spanish
David Primo, PhD (Stanford)
  Associate Professor of Political Science
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
Lizbeth Romanski, PhD (Cornell)
  Associate Professor of Neurobiology and Anatomy in the Center for Visual
  Science
Deborah Rossen-Knill, PhD (Minnesota)
  Associate Professor in the College Writing Program
Nora Rubel, PhD (North Carolina)
  Associate Professor of Religion
Jeffrey Runner, PhD (Massachusetts, Amherst)
  Associate Professor of Linguistics and of Brain and Cognitive Sciences
Joan Saab, PhD (NYU)
  Associate Professor of Art History and of Visual and Cultural Studies
Sema Salur, PhD (Michigan State)
  Associate Professor of Mathematics
Grace Seiberling, PhD (Yale)
  Associate Professor of Art History
Elaine Sia, PhD (Columbia)
  Associate Professor of Biology
Curtis Signorino, PhD (Harvard)
  Associate Professor of Political Science
Donatella Stocchi-Perucchio, PhD (Cornell)
  Associate Professor of Italian
Duje Tadin, PhD (Vanderbilt)
  Associate Professor of Brain and Cognitive Sciences and in the Center for
  Visual Science
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
Thomas Tucker, PhD (California, Berkeley)
  Associate Professor of Mathematics
Michael Welte, PhD (Chicago)
  Associate Professor of Biology
Peter Wyman, PhD (Rochester)
  Associate Professor of Psychiatry and of Psychology
Geun-Young Yoon, PhD (Osaka University)
  Associate Professor of Ophthalmology, of Biomedical Engineering, of Optics,
  and in the Center of Visual Science
Assistant Professor

Antonio Badolato, PhD (California, Santa Barbara)
Assistant Professor of Physics and Astronomy

Yan Bai, PhD (Minnesota)
Assistant Professor of Economics

Corbett Bazler, PhD (Columbia)
Assistant Professor of Music

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

Matthew Blackwell, PhD (Harvard)
Assistant Professor of Political Science

John Boersma, PhD (Texas, Austin)
Assistant Professor of Physics

Jennifer Brisson, PhD (Washington University)
Assistant Professor of Biology

Joel Burges, PhD (Stanford)
Assistant Professor of English

Mandi Burnette, PhD (Virginia)
Assistant Professor of Psychology

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

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

Jessica Cantlon, PhD (Duke)
PhD

James P. Wilmot Distinguished Professor in Arts, Sciences & Engineering and Assistant Professor of Brain and Cognitive Sciences

Bin Chen, PhD (Cornell)
Assistant Professor of Economics

Millicent Chung, MD (Yale)
Assistant Professor of Ophthalmology and in the Center for Visual Science

Elizabeth Colantoni, PhD (Michigan)
Assistant Professor of Classics

Jennifer Creech, PhD (Minnesota)
Assistant Professor of German

Thomas Devaney, PhD (Brown)
Assistant Professor of History

Robert Doran, PhD (Stanford)
PhD

James P. Wilmot Distinguished Assistant Professor in Arts, Sciences & Engineering and Assistant Professor of French

Kristin Doughty, PhD (Pennsylvania)
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Joshua Dubler, PhD (Princeton)
Assistant Professor of Anthropology

Rudi Fasan, PhD (Zurich)
Assistant Professor of Chemistry

Ignacio Franco, PhD (Toronto)
Assistant Professor of Chemistry

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

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

Daniel Garrigan, PhD (Arizona State)
Assistant Professor of Biology

Sina Ghaemmaghami, PhD (Duke)
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Scott Grimm, PhD (Stanford)
Assistant Professor of Linguistics

Margarita Guillory, PhD (Rice)
Assistant Professor of Religion and Classics

Douglas Haessig, PhD (California, Irvine)
Assistant Professor of Mathematics

Robin Harding, PhD (NYU)
Assistant Professor of Political Science

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

Krystal Huxlin, PhD (Sydney)
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Jeremy Jamieson, PhD (Northeastern)
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Celeste Kidd, PhD (Rochester)
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Joshua Kinsler, PhD (Duke)
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Asen Kochov, PhD (Rochester)
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Chigusa Kurumada, PhD (Stanford)
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Jennifer Kyker, PhD (Pennsylvania)
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Bethany A. Lacina, PhD (Stanford)
Assistant Professor of Political Science

Evelyne Leblanc-Roberge, PhD (NYSCC)
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Alexander Lee, PhD (Stanford)
Assistant Professor of Political Science

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Dan Lu, PhD (Chicago)
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*Albert Memmott, PhD (Minnesota)
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Ryan Michaels, PhD (Michigan)
Assistant Professor of Economics

Jason Middleton, PhD (Duke)
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Sevak Mkrtchyan, PhD (Berkeley)
Assistant Professor of Mathematics

Michael Neidig, PhD (Stanford)
Assistant Professor of Chemistry

Wendy J. Nilsen, PhD (Purdue)
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John Osburg, PhD (Chicago)
Assistant Professor of Anthropology

*Part-time
Romans Pancs, PhD (Stanford)
Assistant Professor of Economics

Yena Park, PhD (University of Pennsylvania)
Assistant Professor of Economics

Cary Peppermint, MFA (Syracuse)
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Alison Peterman, PhD (Northwestern)
Assistant Professor of Philosophy

Vasili Petenko, PhD (California, San Diego)
Assistant Professor of Earth and Environmental Sciences

Steve Piantadosi, PhD (MIT)
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Douglas Portman, PhD (Pennsylvania)
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Christian Rabeling, PhD (U of Texas, Austin)
Assistant Professor of Biology

Rajeev Raizada, PhD (Boston)
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Supritha Rajan, PhD (North Carolina)
Assistant Professor of English

Chuang Ren, PhD (Wisconsin, Madison)
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William Schaefer, PhD (Chicago)
Assistant Professor of Modern Languages and Cultures

Keith Schneider, PhD (Rochester)
Assistant Professor (Research) in the Center for Brain Imaging, in Biomedical Engineering, and in the Center for Visual Science

Stephen Schottenfeld, MFA (Iowa)
James P. Wilmot Distinguished Assistant Professor in Arts, Sciences & Engineering and Assistant Professor of English

Llerena Searle, PhD (University of Pennsylvania)
Assistant Professor of Anthropology

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

Maya Sen, PhD (Harvard)
Assistant Professor of Political Science

Brett Sherman, PhD (Princeton)
Assistant Professor of Philosophy

Pablo Sierra, PhD (California, Los Angeles)
Assistant Professor of History

Lisa Starr, PhD (SUNY, Stony Brook)
Assistant Professor of Clinical and Social Sciences in Psychology

Melissa Sturge-Apple, PhD (Notre Dame)
James P. Wilmot Distinguished Assistant Professor in Arts, Sciences & Engineering and Assistant Professor of Psychology

Dustin Trail, PhD (Rensselaer Polytechnic Institute)
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Daniel Weix, PhD (California, Berkeley)
Assistant Professor of Chemistry

Bradley Weslake, PhD (Sydney)
Assistant Professor of Philosophy

Lisa Willis, PhD (Rochester)
Assistant Professor of Psychiatry and of Psychology

Laura Wray-Lake, PhD (Penn State)
Assistant Professor of Clinical and Social Sciences in Psychology

Nese Yildiz, PhD (Stanford)
Assistant Professor of Economics

Elya Zhang, PhD (California, San Diego)
Assistant Professor of History

Jan Toke, PhD (Warsaw Univ., Poland)
Senior Scientist in Chemistry
Biology

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-developmental biology, genetics, ecology, and evolutionary biology.

**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 either plan is one to 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**

Prerequisites: courses in genetics and biochemistry are strongly recommended.

This course deals with the molecular mechanisms of DNA replication, DNA repair, transcription, translation, and control of gene expression. Discussions include cell cycle regulation, programmed cell death, molecular basis of cancer, and modern molecular biology techniques. Emphasis is given to mammalian systems and molecular mechanisms of human diseases.
405. Evolution
Prerequisite: introductory course in genetics.

Introduction to evolutionary biology. Topics include history of evolutionary thought, population and quantitative genetics, origin and history of life, speciation, and human evolution.

406. Eukaryotic Genomes
Prerequisite: introductory course in genetics is required and a course in molecular biology is recommended.

This course provides an overview of the origins of eukaryotic genomes and their current huge variation in size and organization. The remarkable complexity in the structure and regulation of eukaryotic genes and the processing of their transcripts is discussed. Predominately focused on molecular and large-scale sequencing approaches, the course attempts to demonstrate how the data from such approaches must be evaluated in a manner consistent with theories of evolution. Is our genome a finely tuned machine or a wild landscape littered with junk? In an attempt to answer this question the course relies heavily on Dobzhansky’s adage “Nothing in biology makes sense except in the light of evolution.” Readings are from the original literature.

420. Advanced Cell Biology
Prerequisites: introductory courses in genetics, biochemistry, and cell biology are recommended.

An advanced course focusing on a mechanistic understanding of cellular organization and function. This course relies heavily on the primary research literature and emphasizes 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. Introduction to professional skills such as dissecting articles, giving presentations, and writing proposals.

422. Biology of Aging
Prerequisite: introductory course in genetics or molecular biology is required.

This course focuses on molecular mechanisms of aging. Discussions cover 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.

426. Developmental Biology
Prerequisite: none.

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.

443. Eukaryotic Gene Regulation
Prerequisites: introductory courses in genetics, biochemistry, and molecular biology are strongly recommended.

This course systematically examines the organization of the eukaryotic genome and its role in the regulation of gene expression. Topics discussed include structure of chromatin/chromosomes, mechanisms of gene activation and transcription, epigenetic gene regulation, regulatory networks, and functional genomics. Lectures and readings draw heavily on current and classic primary literature.

453. Computational Biology
Prerequisite: none.

An introduction to the history, theory, and practice of using computers to conduct biological research. Topics include the fundamentals of Linux-based computing and perl programming, accessing and storing biological data, alignment of molecular sequences, and computer-based analysis of data.

460. Animal Behavior
Prerequisite: introductory courses in biology and genetics.

Examines animal behavior from an ecological and evolutionary perspective. Topics include social organization, mating systems, foraging, animal learning, and aggression. Students also learn quantitative techniques in behavioral biology.

463. Ecology
Prerequisites: introductory courses in biology and calculus.

An examination of ecology at the levels of individuals, populations, communities, ecosystems, and biomes. Topics include physiological and behavioral ecology, dynamics of natural populations, interactions between species, and the impact of global change on ecological patterns and processes.

465. Molecular Evolution
Prerequisite: introductory courses in biology and genetics.

This course explores evolution at the molecular level. We use evolutionary principles to infer history from DNA sequences, to determine what forces have shaped the evolution of genes and genomes, to understand the relationship between molecular evolution and phenotypic evolution, and to address applied problems, like assigning biological function to genome sequences, finding the sources of epidemics, and finding the genes involved in human diseases.

468. Laboratory in Molecular, Cell, and Developmental Biology
Prerequisites: courses in genetics, biochemistry, and molecular biology are highly recommended.

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, and (3) experience in the design and execution of experiments, reading and writing scientific reports, and public scientific presentation.
471/472/473/474. Advanced Ecology and Evolutionary Biology
A–D
Prerequisite: none.
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. These courses are intended for graduate students; exceptional undergraduate students can enroll by permission of the course coordinator.

480. Graduate Laboratory Rotation
Prerequisite: normally restricted to PhD candidates.
An introduction to research in the laboratories of individual faculty members.

516. Cell/Developmental/Molecular Biology Seminar

517. Graduate Research Seminar

580. Journal Club in Ecology and Evolution
Prerequisite: permission of the instructor.
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.

581. Topics in Cell, Developmental, and Molecular Biology
Credit—two hours
This course is 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 member provides a general introduction to his or her field of interest and a comprehensive overview of his or her own research efforts. Short (one–two pages) papers are assigned throughout the course, critiqued, and returned for rewriting. Grades are determined by participation in class discussions and the assigned writings.

584. Seminar in Evolution
Biology Colloquium. Members of the staff and advanced students in the biological sciences meet on regularly announced dates for presentation and discussion of research by members of the department or invited guests. These meetings are open to all.

CELL BIOLOGY/MOLECULAR BIOLOGY

Several other courses in the field of cell and molecular biology are offered in the School of Medicine and Dentistry. See the section headed Interdepartmental Courses on page 235.

Brain and Cognitive Sciences

Professors Aslin, Bavelier, Chapman, DeAngelis (Chair), Ison, Jacobs, Lennie, Makous, E. Nordeen, K. Nordeen, Pouget, Tanenhaus
Associate Professors Jaeger, Tadin
Assistant Professors Cantlon, Hayden, Kidd, Kurumada, Mahon, Piantadosi, Raizada,
Joint Appointments: Professors Allen, Carlson, Duffy, Haber, Huxlin, Klorman, Marvin, Merigan, Paige, Pasternak, Schieber, Williams; Associate Professors Bennett, McDonough, Mink, O’Neill, Runner; Assistant Professor Gunlogson
Lecturer Miller
Professor Emeritus Kellogg

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 candidates 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.

**CORE COURSES**

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 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, gustation, and olfaction, with an emphasis on the general principles that govern mammalian sensory systems.

**505. Perception and Motor Systems**
An interdisciplinary introduction to perception and action. Topics include the perception of motion, depth, surfaces, pattern and object perception, eye movements, motor planning and organization, and attention.

507. Basic Neurobiology
Explores fundamental concepts of neural organization and function. Covers gross and cellular neuroanatomy, neuronal cell biology, the electrophysiology of neurons and synapses, neurochemistry, spinal circuitry, sensory and motor systems, and higher functions including learning and memory. Includes labs on gross anatomy of the brain and computer simulation of neuronal electrophysiology.

507L. Basic Neurobiology Lab
This laboratory course is taken concurrently with the core lecture course, BCS 507. Seven laboratory sessions provide hands-on experience (brain dissection, cellular anatomy, electrophysiological recording) and demonstrations (behavioral pharmacology) to reinforce concepts introduced in the lecture course and to teach basic laboratory skills relevant to neuroscience.

508. Neural Plasticity in Learning and Development
Prerequisite: BCS 507 or equivalent.
An examination of neural plasticity in development as well as in adult learning and memory. Topics covered are approached from the joint perspectives of behavior, computational modeling, and neural mechanisms.

**EXPERIMENTAL DESIGN, STATISTICS, METHODS COURSES**

510. General Linear Approaches to Data Analysis I
Prerequisite: STT 211 or equivalent.
Issues of data analysis in experimental research. The course focuses on parametric techniques, especially analysis of variance. Topics include simple and complex designs for between and within subjects factors, including mixed designs; analysis of covariance and interaction; 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 noncompliant subjects. 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
This course examines mathematical/computational models of visual perception, decision making, learning, and movement control. The objective is to develop technical knowledge and skills needed to formulate, evaluate, and understand such models.

513. MR Imaging: From Spins to Brains
The core focus of the course is how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing.

514. Laboratory in Neurobiology
Prerequisite: BCS 507 or equivalent.
This course introduces various methods used in neurobiological research. Structured laboratory experiments provide experience with neuroanatomical, neurochemical, neuropharmacological, and neurophysiological approaches to studying neural organization and function. During an extended project, students carry out stereotaxic surgery, collect behavioral measurements, process neural tissue for microscopic analysis, collect anatomical data, and produce a final research paper.

GRADUATE COURSES IN PERCEPTION

521. Auditory Perception
Examines the physiological substrate responsible for hearing. Topics include the physical stimulus for hearing, receptive aspects of speech and language, peripheral physiology (the outer and middle ears, cochlea, and auditory nerve), and central physiology (brainstem nuclei, auditory cortex, descending systems). Introduces electrophysiological techniques used to study auditory function, and explores sensory and perceptual correlates of physiology and sensorineural hearing loss.

524. Advanced Problems in Perception and Action
This is a reading seminar that looks at modern research in a particular problem in perception and action. The topic of the seminar changes from year-to-year and has included topics as diverse as depth perception, statistical learning in perception, multisensory integration, and sensorimotor control. Seminars typically include a mix of students, postdocs, and faculty. Participants are expected to lead discussions of papers in the class, and those who take it for course credit complete a final paper on a subtopic covered in the class.

526. Vision and the Eye
The human visual system is the most sophisticated imaging system known. This course reveals the intricate optical and neural machinery inside the eye that allows us to see. It describes 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. The human eye is compared with the acute eyes of predatory birds and the compound eyes of insects. The course also describes 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 course serves as an introduction to the study of vision for graduate students.

GRADUATE COURSES IN COMPUTATIONAL SCIENCE

532. Probabilistic Theories of Cognitive Processing
Prerequisite: BCS 512 or equivalent.
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 and Language Processing
Prerequisites: CSC 172 and either CSC 240 or 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.

535. 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.

536. Machine Vision
Prerequisites: CSC 242 and MTH 161.
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.

538. Computational Problems in Vision
Advanced seminar on the union of computational work and human vision. Topics vary; typical examples include levels of representation, parallel and serial processing, object recognition, distributed versus local representations, vision with a moving observer, and attention.

GRADUATE COURSES IN COGNITIVE NEUROSCIENCE

541. Integrative and Systems Neuroscience
Prerequisite: BCS 507 or equivalent.
Provides a critical overview of current approaches to the study of systems neuroscience. Topics include connectivity, neurophysiology, and behavioral measures of sensory and motor systems, memory, and attention.

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.

543. Neurochemical Foundations of Behavior  
*Prerequisite: BCS 507 or equivalent.*

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/adoption, longitudinal descriptive, psychophysiogetic, neuropathologic, genetic linkage, and postmortem studies; emphasizes recent in vivo brain imaging and neuroreceptor studies.

547. Introduction to Computational Neuroscience  
*Prerequisite: 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 ends with models of complex cognitive functions, such as sensory motor transformations or sentence processing.

548. Advanced Seminar on Plasticity  
*Prerequisite: BCS 508 or permission of instructor.*

The goal of this seminar is to cover the latest advances on brain plasticity. A wide range of topics is covered, including molecular, cellular, and system-level mechanisms of brain plasticity in animal models as well as humans. All participants are expected to have a good command of the basic principles of neural development and plasticity.

549. Developmental Neurobiology  
*Prerequisite: BCS 507 or equivalent.*

The organization of our nervous system defines the ways we behave, perceive, think, and feel. This course explores factors that influence the differentiation and survival of nerve cells, the functional specialization of neural regions, how axons navigate to targets and accurately map connections within these targets, and how connections are influenced by early perceptual and hormonal experience. Examples of developmental plasticity are compared and contrasted with forms of neural plasticity normally 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.

558. Music and the Mind  
*Prerequisite: previous music theory study (equivalent to TH 115 and TH 116) or permission of instructor.*

Introduction to the discipline of music cognition. Topics include empirical methods, psycho-acoustic principles, Gestalt psychology, music and language, metric and tonal hierarchies, music and the brain, musical development, and research on memory, expectation, and emotion. Students are responsible for readings, discussion, midterm exam, and a major research paper.

560. Proseminar in Music Cognition  

This course is intended both as a survey of primary research in the field of music cognition and as a “laboratory” course in experimental method. Students discuss and critique experimental studies published in journals. In addition, the class works collaboratively to build skills in experimental design and data analysis via a “methods” textbook and class demonstrations/activities. Each student is expected to design and run an experiment as a final project.

561. Speech Perception and Recognition  

Provides an overview of the theories and empirical findings on human speech recognition and perception. Topics include an overview of phonetics, categorical perception, speech perception by nonhumans and by human infants, perception of nonnative speech sounds, intermodal perception of speech, and word recognition in fluent speech.

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
This 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. Signed 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.

565. Language and the Brain
This course examines how the comprehension and production of language is implemented in the human brain. It focuses on spoken language (not written or signed language) and fMRI (not ERPs and other imaging modalities). A number of questions about brain activation to speech vs. nonspeech/music; native vs. nonnative phonetics/phonology; effects of learning/expertise; lexical organization (neighborhood structure) and development; form-class and semantic category constraints on processing; and the role of perceptual brain regions in semantic processing are considered. The course also explores new fMRI analysis methods and experimental designs that could be suitable for addressing these questions.

566. Topics in Understanding Language
This seminar focuses on selected topics in language processing. The specific topic for a particular year to be announced. For graduate students and faculty in the language sciences.

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 explores relationships between musical and linguistic structure and discusses experimental work on prosodic structure in language and on music acquisition in infants. The course reviews basic aspects of phonology, intonational phonology, meter, and memory that are relevant to music.

OTHER COURSES

582. Grant Writing in Brain and Cognitive Sciences
A grant writing workshop designed to train students to prepare effective and successful research grant proposals in the field of brain and cognitive sciences. Students participate in a mock scientific review panel to review sample grant proposals. Through a guided process of peer review and revision, they prepare an NIH NRSA proposal. Many students submit the finished proposal to NIH after completion of the class.

599. Professional Development and Career Planning
The purpose of this 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 are 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.

591. Readings at the PhD Level

595. Research at the PhD Level

598. Supervised Teaching

999. Doctoral Dissertation
The Department of Chemistry concentrates on programs leading to the PhD degree. The Chemistry Graduate Studies Office maintains a booklet with the complete descriptions of departmental requirements for the PhD degree. Departmental information can be found at www.chem.rochester.edu and requirements for the PhD degree can be found at www.chem.rochester.edu/graduate/requirements.php.

The registrar’s list of courses should be consulted to determine which ones are being offered in the current year. Not all of these courses are offered each year. All courses carry four credit hours unless otherwise noted. Some “modular” courses carry two credit hours and are offered during the first or second half of given semesters as indicated.

402. Biophysical Chemistry I
An introduction to the theory and practical application of several major techniques used in the structural characterization of biological macromolecules. (Spring, odd years)

404. Biophysical Chemistry II
Explores how fundamental interactions determine the structure, dynamics, and reactivity of proteins and nucleic acids. Examples are taken from the literature with emphasis on thermodynamics, kinetic, theoretical, and site-directed mutagenesis studies. (Spring, odd years)

406. Interface of Chemistry and Biology
Provides an introduction to recent research at the interface of chemistry and biology by focusing on seminars given in various departments. (Spring, odd years)

411. Advanced Inorganic Chemistry
Descriptive chemistry of main group elements, bonding in inorganic systems, coordination chemistry, and the properties and reactions of transition metal complexes. (Fall)

414. Bioinorganic Chemistry
Prerequisite: CHM 411, or 211 with permission of instructor.
Introduction to the roles of metal ions in biological systems. (Spring)

415. Group Theory
Credit—two hours
Development of symmetry and group theory concepts and scope of applications to chemical problems. (Fall, first half of semester)

416. X-Ray Crystallography
Credit—two hours
Basic principles of X-ray diffraction, symmetry, and space groups. (Spring, second half of semester)

421. Basic Organometallic Chemistry
Credit—two hours
Covers basic aspects of organometallic bonding and surveys a variety of ligands found in organometallic compounds. (Fall, second half of semester)

422. Organometallic Chemistry
Prerequisite: CHM 421.
Credit—two hours
Surveys a variety of organometallic compounds and reactions, focusing on mechanisms in organometallic reactions. (Spring, first half of semester)

423. Nuclear Magnetic Resonance Spectroscopy
Credit—two hours
Covers the fundamentals of nuclear magnetic resonance (NMR) spectroscopy. The physical basis for NMR is described, and practical aspects of optimizing data collection, processing parameters, and interpretation of homonuclear and heteronuclear 1D and multidimensional spectra are covered. (Fall, first half of semester)

425. Physical Methods in Inorganic Chemistry I
Prerequisite: CHM 411.
Credit—two hours
Molecular and electronic structure determination of inorganic compounds and metal complexes; spectroscopic and physical methods that are used in inorganic chemistry. (Fall, second half of semester)

426. Physical Methods in Inorganic Chemistry II
Prerequisite: CHM 415 and 425.
Credit—two hours
Molecular and electronic structure determination of inorganic compounds and metal complexes; spectroscopic and physical methods that are used in inorganic chemistry. (Spring, first half of semester)

427. Organic Structure Determination
Prerequisite: CHM 422.
Credit—two hours
The modern methods and tools employed for the determination of the structure of complex organic molecules are discussed. Among the areas discussed in detail are NMR (1D and 2D), IR,
UV, and mass spectroscopy. Problem-solving techniques are illustrated and problem-solving skills developed by means of problem sets and class examples. (Fall, second half of semester)

433. Advanced Physical Organic Chemistry I
An understanding of the structure and reactivity of organic compounds by using molecular orbital theory is provided. (Fall)

434. Advanced Physical Organic Chemistry II
Structure and reactivity; kinetics, catalysis, medium effects, transition state theory, kinetic isotope effects, photochemistry, reactive intermediates, and mechanisms. (Spring)

435. Organic Reactions
Intended to serve as an introduction to practical, modern organic synthesis for advanced undergraduates or beginning graduate students. It is complementary to CHM 433 (which students are encouraged to take concurrently) and is focused on developing a broad repertoire of chemical transformations required for success as a synthetic chemist. (Fall)

436. Applications of Organometallic Chemistry to Synthesis
Prerequisite: CHM 421.
Credit—two hours
The transition metal-mediated organometallic reactions most commonly employed in organic synthesis are discussed including their substrate scope, mechanism, and stereo- and/or regiochemical course. Emphasis is placed on the practical aspects such as catalyst and reaction condition selection and protocols for trouble shooting catalytic cycles. (Spring, second half of semester)

438. Synthetic Design: Strategy and Tactics
Prerequisite: CHM 435.
Credit—two hours
A formalism describing commonly employed strategies and tactics for the analysis of complex problems in organic synthesis is presented. Examples of such strategies are compared and contrasted during discussion of published complex molecule syntheses. (Fall, first half of semester)

440. Bioorganic Chemistry and Chemical Biology
Presents 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. (Spring)

441. Physical Chemistry I
Introduction to quantum theory of matter, with particular applications to problems of chemical interest. (Fall)

444W. Advanced Nuclear Science Educational Laboratory (ANSEL)
Students enrolled in ANSEL develop a sophisticated understanding of our terrestrial radiation environment and of some of the important applications of nuclear science and technology. They 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. (Spring)

451. Quantum Chemistry I
Basic quantum chemistry, the Schröedinger equation, basic postulates of quantum mechanics, angular momentum, perturbation theory, and molecular structure. (Fall)

452. Quantum Chemistry II
Prerequisite: CHM 451.
Heisenberg representation, advanced theories of electronic structures, angular momentum, perturbation theory, scattering theory, and semi-classical techniques are covered. (Spring)

455. Thermodynamics and Statistical Mechanics
Draws a connection between the microscopically deterministic and/or chaotic dynamics of complex systems and their macroscopic appearance. (Fall)

456. Chemical Bonds: from Molecules to Materials
Introduction to the electronic structure of extended materials systems from both a chemical bonding and a condensed matter physics perspective. The course discusses materials of all length scales from individual molecules to macroscopic three-dimensional crystals, but focuses on zero-, one-, and two-dimensional inorganic materials at the nanometer scale. (Spring)

458. Molecular Spectroscopy and Structure
Prerequisite: CHM 451.
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. (Spring, first half of semester)

460. Chemical Kinetics
Prerequisite: CHM 451.
Credit—two hours
This course focuses on basic concepts of kinetics, photochemistry, and electron-transfer (eT). In addition to studying bulk reaction rates, there are discussions on Marcus’s theory of eT, intramolecular vibrational energy redistribution (IVR), and vibrational cooling, and the fates of photoexcited species (radiative and nonradiative decay channels). (Spring, second half of semester)

462. Biological Chemistry
An introduction to chemical processes of life. Covered topics include proteins and nucleic acids, recombinant DNA technology, biological catalysis, and energy transduction. (Spring)
465. Nuclear Science and Technology I

Introduction to the structure of nuclei and nuclear interactions; experimental and theoretical techniques of nuclear science; interaction of radiation with matter; gross properties of stable nuclei; laws of gamma and particle decay of unstable nuclei; nuclear forces and symmetries; single-particle and collective nuclear models; general aspects of nuclear reactions, nuclear thermodynamics. (Fall, every even year)

470. Computational Chemistry

In this course, students learn about a range of computational methods used to attack research problems in chemistry. Emphasis is placed both on the theory underlying computational techniques and on their practical application. Topics include molecular mechanics, ab initio electronic structure theory, density functional theory, molecular dynamics and Monte Carlo simulations, methods for free-energy calculations, path-integral techniques, and methods for protein structure prediction. (Spring)

486. Energy: Science, Technology and Society

This interdisciplinary course focuses on contemporary, early 21st-century energy issues. It reviews the historical development, present state, and projected future demands on the mainly U.S./American energy production and distribution infrastructure, considered within the boundary conditions of climate change and global competition for resources. (Spring)

511. Chemistry Seminar

Credit to be arranged

Required of all graduate students in physical, inorganic, and biophysical chemistry during each semester they are registered. (Fall and Spring)

513. Chemistry Colloquium

Credit to be arranged

Required of all graduate students in organic chemistry during each semester they are registered. (Fall and Spring)

516. Coordination Chemistry

Prerequisite: CHM 411, 415, and 421.

This course gives an in-depth survey of topics in coordination chemistry. It is structured around a molecular-orbital model, which helps us to understand structures, dynamics, and reactivity. (Spring, second half of semester)

518. Kinetics in Organometallic Reactions and Catalysis

Covers the use of kinetic techniques for the elucidation of the mechanisms of organometallic reactions. (Spring, second half of semester)

566. Nuclear Science and Technology II

Prerequisite: CHM 465.

Covers a limited number of specific topics in nuclear science and technology, but more in depth than the introductory course (NST I). (Spring, every even year)

583. Advanced Chemistry Seminar and Colloquium

Credit—none

585. First-Year Graduate Workshop

Credit—one hour

Pedagogy in chemistry graduate school.

591. Reading Course at the PhD Level

Credit to be arranged

593. Special Topics in Chemistry

Credit—two hours

Advanced topics of current interest.

594. Internship

595. Research at the PhD Level

Credit to be arranged

Research projects chosen by students, limited only by the research interests of the faculty.

899. Master’s Dissertation

Credit—none

997/999. Doctoral Dissertation

Credit—none

Full-time registration category for students who have completed 90 credit hours.
Clinical and Social Sciences in Psychology

Professors Davies, Deci, Elliot, Klorman, Reis, Ryan, Smetana, Zuckerman
Associate Professors Bennetto (Chair), Rogge, Toth
Assistant Professors Burnette, Jamieson, Starr, Sturge-Apple, Wray-Lake
Joint Appointments: O’Connor, Rogosch, Todd-Manly, Wyman
Professors Emeriti Ilardi, McAdam, Wheeler, Zax

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 development 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). The program follows the clinical-scientist model and prepares students for teaching and research positions as well as professional activities with adults and children. Major emphasis is placed on research and scholarly training. Diverse areas of specialization are available, most notably: (1) developmental psychopathology, (2) motivation, and (3) neuroscience. A major resource for training and research is the Mt. Hope Family Center.

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. Only placements of at least 16 hours per week and lasting a minimum of 26 weeks are acceptable.

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.

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.

The department is housed in Meliora Hall, a building with well-equipped laboratories, seminar and teaching rooms, and technical facilities needed to support teaching and research. The department also cooperates and shares facilities with the Mt. Hope Family Center, the Departments of Psychiatry and Pediatrics, and area hospitals, schools, and industrial settings. Psychologists and professionals from other disciplines cooperate to further the objectives of the graduate program. The department offers excellent computing facilities and maintains a computer lab/classroom devoted for departmental use. Licenses for statistical analysis software such as SPSS and Amos are
maintained for use on the lab machines. In addition to its own facilities, members of the department have access to the many resources of the University's various computing centers.

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.psych.rochester.edu/graduate. 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.

**LABORATORY COURSES**

211. Introduction to Statistical Methods in Psychology
219W. Research Methods in Psychology
266. Research Laboratory in Social Psychology
351. Research in Developmental Neuropsychology I
352. Research in Developmental Neuropsychology II
356. Research in Adolescent Development.
373. Exploring Research in Social Psychology I
374. Exploring Research in Social Psychology II
377. Exploring Research in Family Psychology I
378. Exploring Research in Family Psychology II

**ADVANCED LECTURE COURSES**

223. Positive Youth Development
240. Depression and Anxiety
262. Human Motivation and Emotion
263. Relationship Process and Emotions
264. Industrial and Organizational Psychology
267. Psychology of Gender
278. Adolescent Development

280. Clinical Psychology
281. Psychology and the Law
282. Abnormal Psychology
283. Behavioral Medicine
289. Developmental Childhood Psychopathology

**SEMINAR COURSES**

301. Teaching Psychology
361. Social Psychology: Self-Concept
362W. Seminar in the Psychology of Gender
364. Achievement and Motivation
368W. Seminar in Humanistic Psychology
371. Seminar in Social & Personality Development
375. Advanced Topics: Relationships & Emotions
376. Seminar in Self-Determination
381. Psychology of Developmental Disabilities
383. Moral Development
384. Practicum in Developmental Disabilities I
385. Practicum in Developmental Disabilities II
386. Advanced Emotional Development
388. Research Practicum in Developmental Psychopathology I
389. Research Practicum in Developmental Psychopathology II
396. Seminar in Special Topics

The 500-level courses listed below carry three credit hours, except as noted.

501. Ethical Issues in Clinical Psychology

Psychologists have multiple sets of responsibility with information, and these are defined in this course. Individual’s 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.

502. Cognitive Foundations
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.

504. General Linear Approaches to Data Analysis I
Issues of data analysis in experimental research. The course focuses on parametric techniques, especially 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 menu-driven version of SPSS for data analysis.

509. Seminar in Psychotherapy

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 is on proper interpretation of existing research and the design of new research.

514. Structural Equation Modeling
Course covers statistical techniques that comprise Structural Equation Modeling: confirmatory factor analysis, path analysis, and hybrid models (which include latent factors and the structural paths among them). The class covers introductory material (e.g., identification and estimation) as well as some intermediate and advanced topics (e.g., measurement invariance and interactions between latent variables). Previous knowledge of regression is highly recommended.

515. Hierarchical Linear Modeling
This course covers the basic theory and equations underlying multilevel modeling techniques for analyzing hierarchical data. Lectures on the underlying statistics are paired with detailed in-class data analysis examples and hands-on homework sets to ensure that students leave the class fully competent to run and thoroughly interpret their own HLM analyses.

519. Data Analysis: General Linear Applications
Topics include multiple regression, structural equations (e.g., path analysis), and multivariate techniques. The emphasis is practical, focusing on the analysis of actual psychological data.

523. Positive Development during Childhood and Adolescence
Positive Youth Development (PYD) is a focal area within developmental science that examines the processes that enable children and adolescents to be healthy, productive members of society and fully engaged in civic life. The PYD perspective has inspired research and practice that seeks to build on youth people’s strengths and cultivate optimal development. Intentional efforts of families, schools, communities, and youth themselves are the building blocks of youth thriving. This course offers a thorough review of theory and research on Positive Youth Development that spans childhood and adolescence. The seminar-style course is taught from a developmental perspective, but the material is also highly relevant to other areas of study. Topics include resilience, out-of-school time, mentoring, parent involvement, empowerment, civic engagement, and PYD interventions. Through active discussion and writing assignments, students gain in-depth knowledge of individual and contextual factors that relate to positive outcomes among children and adolescents.

549. Psychology of Dual Processing
This course examines implicit and explicit processes in various realms of personality and social psychology; those include self-esteem, attitudes, stereotypes, and goal pursuit. The methodology used to measure implicit processes, the amount of overlap between implicit and explicit aspects of the same construct, and the psychological implications of discrepancies between implicit and explicit processes (e.g., implicit and explicit self-esteem) are among the topics discussed.

550. Social Psychology of Emotion
This seminar covers social psychological research on the nature and expression of emotion. Topics include situational determinants, emotion regulation, individual differences, and the antecedents of specific emotions.

551. Social Cognition
Review of theory and research in two areas: judgment under uncertainty and social attribution. Particular focus on cognitive biases and their effects on perception, probability estimates, and attribution. The relationship between cognition and motivation is also discussed.

552. Human Motivation and 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
Development, maintenance, and dissolution of friendships and intimate relationships. Theoretical and empirical perspectives.
556. Social Psychology of Control
The concept of control—its antecedents, correlates, and consequences—is reviewed. Theoretical and empirical works from the field of developmental psychology, personality, and social psychology serve as reading materials. Examples of topics are helplessness, need for control, perceived control, efficacy, and Type A behavior.

557. Seminar in Interpersonal Development
Takes a developmental psychopathology perspective in exploring the linkages between adaptive and maladaptive interpersonal relations and children’s development over the first two decades of life. Examples of topics include family relations and psychopathology (e.g., depression, alcoholism), quality of peer relationships, friendships, adolescent romantic relationships, and the interplay among these relationship domains.

559. Motivational Research
A seminar that meets weekly to discuss ongoing research on self-determination theory. Limited to doctoral students in the motivation program, with the permission of the instructor.

560. Family Processes in Childhood
Covers the developmental psychopathology of family relationships with a specific focus on how parent-child, interparental, and sibling relationships play a role in the development of children’s psychological adjustment and maladjustment. Current directions in empirical research, theory, methodology, and their interplay are emphasized.

561. Topics in Social Psychology Research
Covers topics in social psychological research and careers.

562. Developmental Research Methods
The goal of this course is to address the nature of different developmental methods and designs and their application to different programs of research, especially as they pertain to central disciplinary issues of stability and change in development. Course curriculum covers characteristics of measurement and methodology (e.g., questionnaires, interviews, observations, developmental assessments), research design (e.g., experiments, quasi-experiments, naturalistic and field research), and analytic models (e.g., multivariate, developmental).

564. Clinical Assessment of Developmental Psychopathology
Advanced seminar covering assessment and diagnosis of developmental disorders across the lifespan. Topics will also include an introduction to neuropsychological assessment and a review of selected treatment strategies.

566. Neurobiological Foundations
This course provides an overview of brain behavior relationships. The course covers historical and theoretical concepts in neuroscience and neuropsychology, the evolution of the primate brain, the organization and functions of the human nervous system, neural development, genetic and environmental influences and plasticity, basic cortical and subcortical structures and the disorders that result from their damage, and principles of neuropsychological assessment.

568. Psychology of Health
Among the topics to be examined are factors affecting longevity, positive illusions and well being, the relation between loneliness and health, coping, and gender and health. The readings mostly reflect social psychology- or personality-related research.

569. Developmental Theory and Research
This course focuses on the theoretical underpinnings of developmental psychology and its implications for current directions in research. The interplay between developmental philosophy, theory, research, and application are addressed, particularly as they apply to current theoretical and research directions in developmental psychology.

570. Clinical Assessment I: Psychometrics
Prerequisites: departmental acceptance for professional clinical training, and statistics (may be taken concurrently).

The purpose of this course is to develop an understanding of psychometric theory and its application to assessment. The course focuses on the following issues: assessment theory, types of tests, test construction and standardization, reliability, validity, test fairness, and ethical and social considerations in testing. Students learn the psychometric characteristics of a variety of widely used assessment instruments and acquire skills in the administration, scoring, and interpretation of these instruments.

571. Clinical Assessment II: Individual Differences
The purpose of this course is to develop a conceptual understanding of personality, aptitudes, and interests. The course focuses on the following issues: comparative theories of personality, descriptive psychopathology, quantitative assessment of interests, personality and psychopathology, projective assessment of personality, and group differences related to age, sex, race, and ethnicity in a variety of domains. Students apply the principles of quantitative assessment and acquire skills in the administration, scoring, and interpretation of a variety of assessment instruments.

572. Introduction to Clinical Research Methods
This course explores an array of methodological issues facing clinical psychology researchers—measure development and validation, sampling effects, power and type II error, efficacy vs. effectiveness, clinical vs. statistical significance, effects of method variance and nonspecific treatment effects—providing a solid foundation in experimental design.

573. Issues in Cultural Diversity
Current topics in psychological differences based on cultural, ethnic, socioeconomic, physical disabilities, and sexual orientation.
574. History and Systems of Psychology and Psychotherapy
This course surveys and compares philosophical frameworks underpinning schools of psychology. Pioneers and leaders in psychology are studied from a historical point of view. Systems of thought underlying approaches to psychotherapy and behavior change, including psychodynamic, existential-phenomenological, Eastern behavioral, and cognitive, are especially emphasized. Critical discussion focuses on the cultural historical contexts as well as the impact of the contribution of the various approaches on other sciences and social, political, cultural, educational, and gender issues.

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
Continuation of CSP 575. Examines general issues of taxonomy of psychopathology; anxiety, disruptive, substance use, psychophysiological, and substance use disorders of childhood, adolescence, and the adult years. The course covers research on description, epidemiology, psychologic deficits, and treatment approaches to these disorders.

577. Research Seminar in Motivation
An advanced graduate seminar that addresses issues related to methods of research in motivation, as well as discussion of theory and application. (Spring)

582. Practicum in Developmental Psychology
Prerequisite: CSP 586 or permission of instructor.
This practicum is designed to build upon CSP 586, "Evidence-Based Child Psychotherapy." Students are exposed to a number of evidence-based models of therapy, including cognitive-behavioral therapy, child-parent psychotherapy, Interpersonal Psychotherapy, PATHS, and Incredible Years Parenting groups. Depending on prior experience and interests, the child case assignments and therapeutic modalities utilized are tailored to individual student goals. Class meetings involve the review of videotaped client sessions.

583. Moral Development
The purpose of this seminar is to examine major theoretical and empirical approaches to moral development. We examine and contrast major theories of moral and pro-social development, including psychoanalytic theories (primarily Freud), cognitive-developmental theories (Piaget, Kohlberg, Turiel, and Eisenberg), and socialization theories. We consider research methods and empirical findings within each approach and discuss the applicability of theories cross-culturally. The primary focus of the course is on psychological approaches to moral development, but we also consider philosophical and applied (e.g., educational) issues.

584. Psychotherapy Practicum I

585. Psychotherapy Practicum II

586. Evidence-Based Child Psychopathology
The overarching objectives of this course include (1) to expose students to historical and current issues with respect to the provision of evidence-based treatments and to examine the research that has contributed to the “support” of various treatments; (2) to examine a number of evidence-based treatments, including cognitive-behavioral therapy, interpersonal psychotherapy, child-parent psychotherapy, and Incredible Years parenting groups. Discussions of these manualized treatments are supplemented with audio- and videotapes of actual clinical cases. NOTE: Enrollment is limited to the department’s graduate students.

587. Overview of Marital Research
This is a survey course exploring the highlights of nearly 30 years of marital and relationship research. The course examines topics including communication behavior, attributions, social support, personality factors, adult attachment, transition to parenthood, and violence in relationships. The course also examines the literature on predicting marital outcomes as well as the divorce prevention literature and the marital therapy literature.

588. Clinical Preceptorial

589. Gestalt Therapy
Experiential training in group psychotherapy, with emphasis on the Gestalt approach. Intended for clinical psychology graduate students in their second year or above, but may be open to others with permission of the instructor.

591. Reading Course at the PhD Level
Credit—normally three hours, upon approval from the Dean's Office

593. Special Problem
Prerequisite: permission of instructor.
Credit to be arranged
The investigation, under guidance, of a special problem in experimental psychology and the presentation of the results of this research in a paper.

595. Research at the PhD Level
Credit to be arranged

598. Seminar in Teaching
Readings, preparation of reports, and discussions of topics in the important relevant literature; evaluation, testing, grading, lecturing, discussion section techniques, the term paper, student motivation, theories of learning applied to instruction, student culture, the ethics of teaching, and college teaching as a career. Limited to graduate students teaching in clinical and social sciences in psychology.
Earth and Environmental Sciences

Professors Ebinger, Garzione (Chair), Mitra, Poreda, Tarduno
Associate Professor Kessler
Assistant Professors Petrenko, Trail
Professors Emeriti Fehn, Lundgren, Sutton
Adjunct Professor Basu

The department offers programs of study leading to a PhD in geosciences and an MS in geological sciences. These programs provide classroom, laboratory, 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, solid earth geochemistry, noble gas geochemistry, cosmogenic isotope geochemistry, light stable isotope geochemistry, environmental geochemistry, geodesy, sedimentary geology, stratigraphy, structural geology, and tectonics. Information on this research can be found at the department’s website: www.ees.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. A rare gas mass spectrometer is used for high-precision He, Ne, and Ar isotopic measurements. Sample preparation is undertaken in the department’s cleanlabs, which feature Class 100 air supplies, laminar flow workspaces, and metal-free environments.

Research in paleomagnetism and rock magnetism is carried out in the paleomagnetic laboratory, which features two 2G DC SQUID Superconducting Rock Magnetometers (4.2 cm. and 6 mm bore), a Princeton Measurements 1900 Alternating Gradient Force Magnetometer, and a Geofyzika JR-5A high-speed automatic spinner magnetometer and an AGICO KLY-4 Kappabridge. Data are analyzed using Sun Microsystems UltraSparc workstations.

The active tectonics and geodynamics research laboratory utilizes Unix workstations to analyze, interpret, and simulate seismic, geologic, and remote sensing data. Broadband seismometers and GPS receivers are used for rapid response to seismic and volcanic events. Longer-term deployments benefit from membership in UNAVCO and IRIS-Pascal equipment pools.

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 luminoscope, Numonics digitizer, and IBM PC and Mac computers with various structural and graphics software.

The new ice core laboratory stores 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 ice core lab also has an ultra-clean system for extracting methane and carbon monoxide 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-ringdown 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. This lab also contains Lamont-Radon Stripping Boards for collecting and trapping methane from water and sediment samples in the field and vacuum lines for preparing the trapped methane samples for natural stable and radiocarbon isotope analyses using isotope ratio and accelerator mass spectrometry. Finally, the lab contains a biogas hood and several culturing/analytical apparatuses for the real-time analysis of chemical and isotopic dynamics associated with biogeochemical processes. 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.

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 three hours of graduate credit each. A limited number of 200- and 300-level courses may be taken for three hours of graduate credit either 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.

The following courses are regularly offered:

**201. Evolution of the Earth**
Dynamic history of the earth, its age and evolution, and the origin and evolution of life as revealed by the geologic and fossil record. (Spring)

**203. Sedimentology and Stratigraphy**
Sediments and sedimentary rocks cover or underlie much of the earth’s surface. In them are recorded both evidence of the processes responsible for shaping the planetary surface and the record of life. Sedimentary rocks contain enormous volumes of water and solid and fluid hydrocarbons, as well as other natural resources. Sediments and sedimentary rocks are very important to our way of life and they are fascinating in themselves. In this course, we describe and classify sedimentary rocks toward understanding the processes that shape them and the environments in which they form.

**204W. Earth Materials**
The goal of this course is to provide an overview of the chemical and physical properties of the material constituents of the Earth and terrestrial planets, including minerals, rocks, and lavas. The class explores the relationship between the atomic structure and the properties of naturally occurring solids and the basic principles that govern the composition and occurrence of these materials. Laboratories are devoted to exercises in crystallography, X-ray diffraction, optical mineralogy, and hand-specimen mineral identification.

**205/405. Solid Earth Geophysics**
This course is intended for motivated students who are interested in an introduction to geophysics. Material covered focuses on deep Earth processes: an introduction to potential fields, gravity, heat flow, magnetic fields, propagation of seismic waves and a bottom-up approach to core processes, mantle flow, and plate tectonics.

**206/406. Petrology-Geochemistry**
Distribution, description, classification, and origin of igneous and metamorphic rocks in the light of theoretical-experimental multicomponent phase equilibrium studies; use of trace elements and isotopes as tracers in rock genesis; hand specimen and microscopic examination of the major rock types.

**207. Principles of Paleontology**
This course is designed to introduce the basic principles of paleontology—the study of fossil organisms in the geological record. Topics covered include taphonomy and the process of fossilization; principles of evolution as evidenced by the fossil record; taxonomy and the recognition and naming of fossil species; biostratigraphy as a means of dating a rock and/or learning about ancient environments; geochemistry of fossils as a means to understand ancient habitats and behaviors. The course includes an overview of important fossil groups with hands-on experience and a field trip.

**208. Structural Geology**
Geometric analysis of deformed rock, mechanical properties of rock, theories of rock deformation. (Fall)

**211. Geohazards and Their Mitigation: Living on an Active Planet**
Earthquakes and volcanic eruptions are violent manifestations of plate tectonics, the movement of the relatively rigid plates forming earth’s outer shell. Ground moving and shaking from these events may generate tsunamis, slumping and mass wasting, and increase risk in other areas. Global and regional sea level rise changes forces on the plates, motivating reconsideration of hazard assessments. Large volumes of aerosols and greenhouse gases are emitted during volcanic eruptions, with implications for global climate change. The first third of the class focuses on the causative mechanisms of earthquakes, volcanoes, tsunamis, and volcanic-eruption-induced climate change. The second third outlines the consequent hazards and forecasting efforts and feedbacks between these processes. The final third of the course examines mitigation programs, with numerous case studies.

**212/412. A Climate Change Perspective to Chemical Oceanography**
Most introductory courses in 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 perspective to conventional chemical oceanography courses but interweaves the unifying theme of climate change into these numerous and diverse topics.

**213. Hydrology and Water Resources**
This course examines the physical flow of water through the natural environment and its use as a resource for human consumption. The first section of the course looks at the characteristics of water on the Earth: physical and chemical properties, global water balance, and basics of hydrology. The second section concerns understanding and calculating water flows: precipitation, evaporation and evapotranspiration, surface and subsurface runoff, and atmospheric transport. The third section addresses the interaction of humans with water resources: storage in dams, hydropower, municipal usage, agriculture, floods, and water conservation.

**215. Environmental and Applied Geophysics**
This course aims to image the internal structure of the oceans and continents using geophysical methods. Topics include physical processes occurring within Earth’s plates, including solar and internal energy sources, movement of fluids in the oceans and plates. Geophysical methods used to detect these processes and to constrain physical properties, including seismic, electromagnetic
gravity as measured from surface, subsurface, and satellites. Laboratory examples include environmental site remediation, hydrocarbon and mineral exploration, archeological remote sensing, tsunami detection, and groundwater exploration.

216. Environmental Geochemistry
A course in the chemical and physical processes that shape our environment. These include groundwater flow and contaminant mitigation; chemistry of lakes, streams, and the ocean; ocean-atmosphere interactions (ozone depletion); global warming; and the greenhouse effect.

217/417. Physical and Chemical Hydrology
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 and geologic controls on groundwater flow. The third and final part of the course deals with natural groundwater geochemistry and environmental contamination.

218/418. Atmospheric Geochemistry
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. Lectures, discussions, and hands-on activities work toward an understanding of several important questions. How did the Earth acquire an 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?

219. Energy and Society
Prerequisite: juniors and seniors in the natural sciences and engineering are required to enroll in EES 219.

National and worldwide patterns of energy production and consumption of renewable and nonrenewable energy sources and the connection of those patterns to socioeconomic conditions. For each source, the course considers the environmental effects of extraction, distribution, and consumption, how efficiently the resource is used, and for what end uses; current reserves and projections for the future and socioeconomic and political factors affecting the resource’s utilization. Also addressed are interactions between energy use and climate change and food and water resources.

222. Energy Resources
Examines the mechanisms of oil and natural gas formation: the time, temperature, and pressure conditions. Explores the geochemical and isotopic fingerprints that lead to successful exploitation of hydrocarbon resources. (Spring)

241/441. Igneous-Metamorphic Petrology
Lectures cover an overview of igneous and metamorphic petrology. Origin and distribution of the major igneous-metamorphic rocks in the light of experimental and theoretical multicomponent phase-equilibria studies are the major topics of the lectures. Trace element distribution and isotopes as petrogenetic tracers in the evaluation of the crust-mantle system are also covered in the lectures. Laboratories are devoted to description, identification, and significance of mineral assemblages in these rocks as observed in hand specimens and under the petrographic microscope. (Spring)

248/448. High Temperature Geochemistry
An introduction to the principles of geochemistry. The first portion of the course is devoted to basics, especially thermodynamics and isotope (both stable and radio-) geochemistry. The middle portion of the course deals with high-temperature processes and crystallization. The last part of the course covers low-temperature processes including weathering, sediment genesis, and element cycling through the lithosphere. (Spring)

251/451. Introduction to Remote Sensing and Geographic Information Systems
Students learn the basic principles of satellite, airborne, shipborne, and other remote sensing data acquisition systems, and the principles of analyses and interpretation of acquired data sets. Case studies and computer-based practicals focus on visible near-infrared, thermal, sonar, and radar imaging of Earth’s continents and seafloor and planetary surfaces. Course material includes a review of geographic coordinate systems and projections for georeferencing remotely sensed data as a basis for Geographic Information Systems analyses. Assessment is through computer-based practicals and a short-answer midterm exam.

252/452. Marine Geology
This course provides a comprehensive review of modern marine geology with an emphasis on the deep sea. Areas identified by the Joint Oceanographics Institution as high research priorities are discussed, including new techniques used to study such problems. Four subject areas will be addressed: the lithosphere, tectonics, ocean history, and sedimentary geochemistry and physical processes. (Spring)

253/453. Geodynamics
Processes that create and modify earth and the terrestrial planets will be examined using an “earth engineering” approach. Emphasis is placed on plate tectonics, with discussion of current research in mantle convection. The final third of the course focuses on active plate tectonic boundaries and evidence for plate tectonics on Mars and Venus.

254/454. Geographic Information Systems: Earth Science Applications
This course provides an introduction to Geographic Information Systems, with an emphasis on their application to issues in the earth and environmental sciences. Examples of applications may include land use (and environmental contamination) and its relationship to geology, hydrology, and climate. Other applications (time permitting) include a survey of computer packages routinely used in the marine geoscience community.
255/455. Planetary Science: Geologic Evolution and Planetary Habitability
EES 255 focuses on geological and geophysical studies of planets (interiors and surfaces) and the conditions that led to the origin of life. The course starts with initial conditions, defined here as the formation of earth and the moon-forming event and trace development of the planet from cooling of the magma ocean onwards. We next consider how our planetary neighbors (Venus and Mars) evolved, as well as key satellites in the solar system that may harbor life, or provide insight into early conditions on earth.

266/466. Topics in Climate and Environmental Change
This seminar course explores specific topics in the field of climate and environmental change. The seminar delves into the classic as well as most current literature in the selected area. Students get practice with reading and understanding primary scientific literature, scientific discussion and debate, oral presentation of scientific results, as well as scientific writing. Specific topics vary each semester.

256/456. Paleomagnetism and Global Plate Tectonics
The basic paleomagnetic methods used to determine absolute plate motions are reviewed. Applications include the potential cause and effect relationship between changes in absolute plate motions, mantle plume volcanism, orogeny, and climate change. (Spring)

257/457. Topics in Advanced Seismology
This course examines wave propagation in the Earth and introduces helioseismology. Classes focus on theory of waveform modeling, moment tensor inversions, low-frequency earthquakes, and related topics. Laboratory work focuses on Matlab-based programming.

258/458. Hotspots and Plate Motions
This course provides 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 are discussed, as well as the basic elements of grantsmanship. (Spring)

259/459. Seminar in Paleomagnetism
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.

260/460. Paleoenvironmental Reconstruction Using Light-Stable Isotopes
This class focuses on techniques used in environmental reconstructions to address questions related to paleoclimate, paleotemperature, paleovegetation, and paleoelevation. Use of stable isotopes in paleoenvironmental reconstructions with particular emphasis on O, C, and to a lesser extent, H and N isotopes is examined. The class starts with a thorough introduction of the geological framework of the environments of interest and the processes of light isotope fractionation. This is 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.

265/465. Paleoclimate
The Earth’s climate is changing in a potentially fundamental way because of human activity. This course looks into Earth’s climate history in order to gain a better understanding of how the climate system works and what to expect from Earth’s climate in the future. During its history, the Earth has gone through periods that were much warmer than periods that were much colder than today. By examining the geological record of the environmental conditions, insights into how key parameters such as greenhouse gas concentrations, insolation, and positions of the continents influence the climate system can be gained.
299. Field Geology  
Prerequisite: permission of instructor.

This course covers the essential geologic and geophysical approaches to field stratigraphy, mapping, and structural interpretation. The coursework is based on observations made during a substantial field excursion (usually six weeks long). Additional credit may be earned by laboratory analyses of samples collected during the field excursion.

312W/313W. Research in Ocean Biogeochemistry I and II  
Credit—two hours/two hours

This course follows the scientific process conducting oceanographic research in the laboratory and at sea. The course begins during the spring semester, extends into the summer with a research expedition at sea lasting approximately two weeks and concludes during the fall semester. During the spring semester (EES 312W), this course meets for two credit hours, and students work together and with the instructor to develop scientific hypotheses related to modern oceanographic biogeochemical processes. The students also develop their own experimental plan to test their hypotheses, formulate a formal written research proposal for their proposed research, and begin their experiments. During the summer, the students collect samples and make measurements at sea with the instructor, other professional scientists, and graduate students. During the fall semester (EES 313W), the students reconvene for another two credit hours to analyze their data and create formal presentations of their scientific work in both written and oral formats. Students must complete both EES 312W and 313W to receive full credit for this course.

320/320W. Sustainable Systems

This course examines sustainable systems at multiple scales: an individual building, a university campus, and a metropolitan community. It combines theoretical discussion with case studies, looking at what issues are the same at each scale and what changes with scale. At the building scale, the focus is on energy, water, and waste. The campus scale analysis broadens to include food, procurement policies, and transportation. The city-wide case study further addresses principles of sustainable urban design. A final project is to develop a practical set of recommendations for a sustainable system, at a scale selected by the student.

360/460. Environmental Geology in the Field and Laboratory

Emphasizes commonly employed methods of obtaining critical geochemical and hydro-geologic data for environmental studies. Visits to drilling sites, geotechnical and analytical labs, and an experimental field station where tests on monitoring wells can be performed. (Fall)

445. Solid Earth Geochemistry

Composition, structure, and evolution of the earth over the past 4.56 billion years; isotopic geochemistry of crust-mantle processes; phase transitions within the earth and their tectonic significance.

462. Seminar in Noble Gas Geochemistry

This course examines topics in noble gas geochemistry through a series of recent articles on various topics.

467. Isotope Geology

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 and fluid movements, history of cosmic ray flux, and other applications of isotopic systems to geologic problems.

480. Material Properties of Deformed Rocks

Elastic, linear, and nonlinear viscous and perfectly plastic behavior of rocks. Effect of dislocation and diffusional creep, grain boundary slidding, microfracturing, and recrystallization on rocks.

481. Microtectonics

Study of microstructures, fabric, and textures in rocks to define deformation patterns, deformation mechanisms, and flow laws.

482. Metamorphic Processes

Metamorphism and its effect on rocks. Pressure-temperature regimes of metamorphism. Tectonic processes related to metamorphism. Case studies from mountain belts.

484. Stress and Strain in Rocks


489. Topics in Advanced Structural Geology

Prerequisite: permission of instructor.

Advanced structural geology course covering topics of current research interest. Topics vary.
Economics

Professors Bils, Chang, Engerman, Govindan (Chair), Jones, Landsburg, Thomson
Associate Professors Barelli, Hong
Assistant Professors Bai, C. Caetano, G. Caetano, Chen, Kinsler, Kochov, Lu, Michaels, Pancs, Yildiz
Joint Appointment: Professors Duggan, Kalandrakis
Senior Lecturer Wolkoff
Lecturer Rizzo

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, public finance, 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 written qualifying examination in each field of specialization. A distribution requirement, satisfied by taking a graduate course in two fields other than the student’s preparation, 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 II
Introduction to general equilibrium analysis, including modern treatment of existence, stability, and comparative statics properties; elements of capital theory.

475. Macroeconomics I
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 with the themes developed in 475: business cycles, economic growth, fiscal and monetary policies. More emphasis is placed on the tools required to do modern macroeconomics: dynamic programming, difference equations, Markov chains, etc. Computational techniques such as linear quadratic and discrete state space dynamic programming, the Coleman algorithm, and parameterized expectations are taught. (No prior knowledge of these techniques is assumed.)

481. Introduction to Math Economics I
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. Introduction to Mathematical Economics II
Credit—two hours
This course is a brief introduction to measure theory and integration. Topics covered include measures; measurable functions; Lebesgue integration; convergence criteria; decomposition of measures; product measures. The course also includes applications of measure theory to probability theory.

483. Introduction to Mathematical Statistics
Credit—two hours
Elements of probability theory and statistics, as employed in the econometrics sequence ECO 484–485.

484. Introduction to Econometrics
(Same as APS 514)
Prerequisite: ECO 483 or permission of department.
Credit—two hours
Estimation and hypothesis testing in the standard linear model; small and large sample properties; generalized methods of moments.
485. Introduction to Econometrics  
(Same as APS 515)  
Prerequisite: ECO 484.  

491. Reading Course at Master’s Level  
Credit to be arranged

493. Master’s Essay  
Credit—three hours

495. Research at the Master’s Level  
Credit to be arranged

501. Seminar in 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.

503. Topics in Labor Economics  
Selected topics in labor economics are discussed. Second semester of labor economics sequence.

507/508. Economic Theory Workshop  
Topics in economic theory, with papers by faculty and outside speakers. Students are expected to be informed discussants and to present a paper.

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

511/512. International Economics Workshop  
Topics in international economics, with papers by faculty and outside speakers. Students are expected to be informed discussants and to present a paper during one semester.

514. Topics in International Economics  
This course is an advanced topics course in international economics. The focus is on international risk sharing, current account dynamics and sovereign debt. Emphasis is on small open economy models.

519. Topics in Microeconometrics  
Prerequisite: ECO 517 or permission of instructor.  
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 Econometrics  
This course focuses on recent developments in mathematical statistics and their applications in econometrics. We use the asymptotic theory of decision (LeCam) to systematically derive optimality properties of various parametric tests.

521. Advanced Economic Theory  
This course covers the foundations for the theory of dynamic incentives, applied to repeated games and to repeated moral hazard/incomplete enforcement. We emphasize recursive methods to characterize the set of subgame perfect equilibria of repeated games and optimal contracts in the repeated moral hazard/incomplete enforcement case. Additional topics include renegotiation proofness, Coasian dynamics and time consistency, and extensions of the static principal-agent problem to multiple agents/multiple principals.

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.

524. Topics in Game Theory  

525. Economic Mechanisms  
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 dynamic.

531/532. Macroeconomics Workshop  
Topics in macroeconomics, with papers by faculty and outside speakers. Students are expected to be informed discussants and to present a paper during one semester.

534. Topics in Macroeconomics  
Studies dynamic macroeconomic models with heterogeneity in age, income, and wealth across agents. Examines the interplay between macroeconomic variables and inequality. Reviews evidence concerning the models discussed.
535. Quantitative Macroeconomics
This course introduces various computational methods in macroeconomics and its applications. The main topics are: (1) learn computational methods, which are extensively used to answer many interesting questions in macroeconomics, and (2) learn how to apply the methods to different interesting issues.

536. Applied Macroeconomics
Credit—three hours
This course considers theories of aggregate fluctuations and unemployment in light of a broad set of empirical regularities.

547/548. Econometrics Workshop
Topics in econometrics, with papers by faculty and outside speakers. Students are expected to be informed discussants and to present a paper during the semester.

551/552. Applied Economics Workshop
Topics in applied economics, with papers by faculty and outside speakers. Students are expected to be informed discussants and to present a paper during one semester.

571. Readings in Macroeconomics
Credit—two hours
Faculty and students go through a series of recent working papers in macroeconomics with emphasis on quantitative and empirical topics.

575. Political Economy I
This course focuses 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 decision making, 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.

582. Political Economy II
The course develops and uses theoretical models with economic and political elements. A range of issues is studied with specific applications varying from year to year.

584. Seminar in Industrial Organization
Modern theory of industrial structure and conduct is covered along with empirical studies of its validity. Topics include analysis of pricing, product differentiation, entry and merger. Consequences of concentration and collusion for efficiency and technical progress are examined as well as appropriate policy responses.

591. Reading Course at the PhD Level
Credit to be arranged

595. Research at the PhD Level
Credit to be arranged

English
Professors Bleich, Eaves, Gross, Hahn, Higley, London, Longenbach, Michael, Peck, Scott
Associate Professors Grella, Grotz, Kegl (Chair), Mannheimer, Tawil, Tucker
Assistant Professors Burges, Middleton, Rajan, Rozenski, Schottenfeld
Adjunct Appointments: Balmain, Carli, Karn, Lupack, Memmott
Senior Lecturers Maister, Rice, Smith
Lecturer Johnson
Professors Emeriti Gavin, Gollin, B. Johnson, J. W. Johnson, Ramsey

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 readings 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 are expected to teach one section of College Writing each semester during years two through four; the candidates’ teaching is supervised by the director of the College Writing, Speaking, and Argument Program. Before 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 exams must be taken before the end of the second year.

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, whom students generally ask
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; and 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 a student’s total credit hours. The real heart of any graduate student’s curriculum should inhere in the 500-level seminars—a sampling of which appears below.

**A SAMPLING OF GRADUATE SEMINARS**

**507. The Writings and Culture of John Gower and William Langland: Studies in Self-Composition**

The goals of this seminar are three: (1) to provide a close reading of two major poems of England’s second literary Renaissance in the fourteenth century—Gower’s *Confessio Amantis* and Langland’s *Piers Plowman* (the B-text)—within the ethical polemics, theory of rhetoric, and the development of sophisticated psychological structures of their cultural environment; (2) to explore as a form of pedagogy concepts of the relativity of “self” and “uncertainty” through elaborately devised first-person narrators and fictional “autobiography”; (3) to develop a phenomenology of “being there” that sophisticates concepts of landscape and place amidst a “middel-weie” on middle earth.

**507. Matrix of Wisdom: Medieval Women Writers**

“The Matrix of Wisdom” examines writing and recorded speaking of Medieval Western European women. Starting with the nineteenth-century Carolingian noblewoman Dhuoda and her letters to her son, we end with Joan of Arc’s trial in the fifteenth century and the transcripts of other women brought before the Inquisition. This course mingles secular writings with religious; romance and protest with vision. Abbess, nun, mother, widow, court poet, heretic, and convert come together in these selections from Hildegard of Bingen, Elisabeth of Schönau, Na Prou Boneta, Marguerite Porete, Heloise, Margery Kemp, Marie de France, Julian of Norwich, Christine of Pizan, and others. The focus of the course is wise transgression: under what conditions could women challenge the rules that kept them from writing, roaring, preaching, objecting, cross-dressing, doing battle, chastising popes and monarchs, challenging church doctrine, starting epistolary “flame wars” with learned men over *The Romance of the Rose* (as in Christine’s case), or from speaking out at all? Another is the relationships women nurtured with fellow women and the men who were loyal.

**507. Fictions in the Mother Tongue: Vernacular Style and Interpretive Communities in Late Medieval England**

We examine the literary resources of a nonstandard, multilingual, increasingly condensed, insular society—late medieval England. The last generation of the fourteenth century created a remarkable concentration of “serious” writing—attempts to express and confront, for the first time in the mother tongue, the meaning of life, the fear of death, the nature of love, the encounter with Otherness—all of this addressed to undifferentiated, discontinuous readerships who (judging from manuscript evidence) couldn’t get enough. At the heart of the course are two ambitious, deeply challenging works: Langland’s *Piers Plowman* and Chaucer’s *Troilus and Criseyde.* We also look at other works that, like Langland, connect vernacular language and style with the search for existential solace (Julian of Norwich, Pearl), and narratives that invent encounters with value systems at variance with readers’ assumptions, like Mandeville’s *Travels, St. Erkenwald,* and *Patience.*

**508. Disruptive Technologies**

This course focuses on the sponsorship, production, circulation, and consumption of European media that create and share images of peoples outside Europe. It considers a range of mainly English but also French, German, Dutch, and Latin materials, assessing their make-up, status, and uses for a variety of audiences over time, using recent work in the history of the book, the sociology of texts, and the revolutionary impact of print. This course introduces a series of texts—Marco Polo, Mandeville’s *Travels,* accounts of the discoveries in the East and West, Utopia, travel writings—that span the conventional medieval-Renaissance divide and look at recent challenges to schemes of periodization.
A central and repeated focus is the manuscripts, illuminations, printed texts (in various formats), and mass-produced images in book illustrations and as standalone engravings that bring these materials to audiences with varying literacies (visual and verbal) and in different language communities.

524. Satire

This course focuses on the satire of the British eighteenth century (often referred to as The Golden Age of Satire), but branches backward and forward (and across the Channel) to think more generally about how to define this multifaceted, multigeneric, literary mode. The primary texts explore larger theoretical questions about how satire operates; its relationship to parody, to comedy, and to tragedy; and the differing satiric forces of different aesthetic forms, whether verse, visual art, prose-narrative, drama, or film. Readings include works by Horace and Juvenal; Rochester, Wycherley, Pope, Swift, Fielding, Montagu, and Gay; Molière, Voltaire, Montesquieu, and Graffigny; Wilde and Brecht. Visual satire by Hogarth is also considered, as well as a handful of films (Capra, Sturges, Hal Ashby).

529. Radical Romantic Artistic Theory

The radical shift in ideas about literature in the British Romantic period (c.1775–1825)—an era of enormous innovation, transformation, and stress—motivated writers to re-examine the foundations of their artistic lives and question the status of literature and its relation to the world. How, they wondered, could they justify their lives as producers of mere literature? Are poets “unacknowledged legislators of the world” (Shelley)? Can imagination transform the world (Blake)? Inspired by contemporary political revolutions, Romantic writers developed core artistic theories that are indispensable in our own thinking—originality, imagination, self-expression, nature (capital N), art (capital A). Such ideas provide a platform for considering other ideas that concern us: self, other, gender, race, etc. Unless we understand what the Romantic writers were up to, we shall not understand ourselves. The seminar also considers practical matters—what it takes to be a practicing academic.

538. Literary Exceptionalism and the Invention of “American Literature”

In the 1780s, Anglo-American writers suddenly began to claim that their writing embodied “American” qualities. The only problem was, before writers could offer a truly “American literature” to readers, they would have to figure out what on earth it was supposed to look like. At the moment the idea was born, no one had yet considered what it would mean to write “like an American,” nor what sorts of literary characteristics Americanness was supposed to generate. Fast forward to 1855, when Walt Whitman first published Leaves of Grass. Now it seemed completely self-evident to writers, readers, and critics that American writing possessed unique aesthetic qualities that could not possibly exist anywhere else in the literary universe. This course traces the history of this idea through the literary works that were said to embody it, from its first stirrings after the Revolution, through the burgeoning cultural nationalism of the 1820s, and culminating in the solidification of a national literature in the 1850s.

540. Lyric Modernity in Nineteenth-Century United States

This seminar focuses on poems and prose by Poe, Whitman, and Dickinson. Students also read and discuss poetry by their predecessors and contemporaries who define the Western lyric tradition, the tradition that critics have long identified as dominant for modern poetry. The work and influence of Sappho, Petrarch, Lydia Sigourney, Sarah Whitman, Byron, Baudelaire, Mallarmé, and others help direct investigations into the emergence of literary modernity in the nineteenth century. The course closely considers recent critical and textual debates about the character of poetic genres and changing nature of literature in nineteenth-century United States and European culture. Topics include the pressures of a changing literary market place, the significance of the “poetess” figure in American and British print culture, and most important, the peculiar formal and rhetorical strategies that Poe, Whitman, and Dickinson develop to engage and resist a rapidly modernizing and increasingly secular national and global environment that they in turn help to define. Students gain a richer sense of how literary modernity both differs from and continues the traditions that preceded it and the part that these particular U.S. poets play in defining what modern poetry will mean and what it won’t mean as well.

549. WWI and the Culture of Memory

The Great War, Paul Fussell has famously argued, initiated a new form of distinctly modern memory—unsparing, unsentimental, and essentially ironic. At the same time, it ushered in an unprecedented era of remembrance that transformed Great Britain into a culture obsessed with the commemoration of its war dead—in a manner anything but ironic—and with preserving the memory of the war as a piece of cultural heritage. In fact, long before the war was over, the people of Britain—both soldiers and civilians—were imagining how to remember it and devising the administrative and aesthetic structures that would shape so much of its postwar memory. So powerful was this impulse—and so pervasive was the postwar obsession with memorialization—that Geoff Dyer has argued, “The war, it begins to seem, had been fought in order that it might be remembered, that it might live up to its memory.” Recently, scholars of the war have begun to question not only how the war was remembered but whose war has been remembered and whose memories valued, opening the established history of the war to other narratives: war as experienced, for example, by women, working class men, colonial soldiers, and laborers. And they have illuminated the way memory is fabricated to produce myths of the war that, over time, serve changing interests. This seminar explores the work of memory in some of the many memoirs and works of imaginative literature that appeared in the decades immediately following the war (e.g., Robert Graves, Vera Brittain, Ford Madox Ford, Virginia Woolf). This course considers the prodigious production of war poetry and the posthumous canonization of the “war poets” (e.g., Brooke, Owen, Sassoon, Rosenberg). Students focus on the appropriation and transformation of the war and its memory in late-twentieth-century literature, film, and television. The course also explores as a critical framework, the rich body of theoretical and historical scholarship on memory work, collective memory, and memorialization, not all of it specific to the WWI context.
550. Problems in Agency
This seminar focuses on how scholars have theorized the concept of agency within a variety of disciplines, from philosophy and critical theory to anthropology and sociology. The question of “agency”—what it means for a person to act as well as the mental states (e.g., emotions or intentions) and sociological structures that condition the individual’s freedom and capacity to act—have been vital questions for some time. While this interest in the problem of agency has been particularly pressing since the poststructuralist “decentring of the subject” and Marxist ideology critique, the problem of agency has a long philosophical history. This course traces the concept of agency from earlier philosophical accounts to more recent theorizations of agency in Marxism, poststructuralism, political theory, and aesthetics. Along the way, it pays particular attention to how problems in agency intersect with the recent critical interest in the “affects” and the efforts by scholars to link aesthetics, ethics, and politics. Readings range from Aristotle and Immanuel Kant to Anthony Giddens, Stuart Hall, and Hannah Arendt.

550. Modern Poetry
A close study of several major modernist American poets (Ezra Pound, T. S. Eliot, Gertrude Stein, Wallace Stevens, Marianne Moore), stressing both the formal extravagance and the historical situation of their poems, along with an examination of a few of the most influential critical paradigms that have been brought to modern poetry and to modernism at large over the last few decades (Hugh Kenner’s The Pound Era, Marjorie Perloff’s Poetics of Indeterminacy, Michael North’s The Political Aesthetic of Yeats, Eliot, and Pound).

551. Reading Lyric Poetry
The seminar explores ways of analyzing and describing lyric poetry, the work of what is often called “close reading,” focusing on questions of poetic form, voice, verbal ambiguity, poetic allusion, and other such issues. The course concentrates on the work of a small group of poets (including Shakespeare, Donne, Hardy, Stevens, and Bishop), reading the work of critics who illustrate both the practice of close reading and the theoretical questions it raises, as well as discussing the nature of lyric poetry more generally. See the English department website for a fuller description.

552. Critical Theory/Media 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. The 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—ground the class so that students can gain a deeper sense of how to do theoretical work that yields supple accounts of media aesthetics.

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 affect 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), as well as cognitivist approaches to cinematic emotion (Carl Plantinga, David Bordwell). Students also read work in cultural theory that could include Lauren Berlant, Sianne Ngai, and Sara Ahmed. With attention to the “post-” of the seminar’s title, the class examines not only films but different forms of media that challenge and reconfigure the boundaries of the cinematic object.

555. Modern Film Theory
This seminar examines major works of film theory, with a focus on 1970s screen theory through the present. Students discuss theoretical approaches, including semiotics, apparatus theory, psychoanalysis, Marxism, genre studies, feminism, and phenomenology. Beginning with Christian Metz’s consideration of “cinematographic language,” the course traces the development of contemporary film theory through multiple and often competing approaches. Readings include selections from Metz, Jean-Louis Baudry, Stephen Heath, Kaja Silverman, Laura Mulvey, Mary Ann Doane, Tom Gunning, Miriam Hansen, Vivian Sobchack, Fredric Jameson, Slavoj Zizek, and others. Students also screen and discuss pertinent examples of Hollywood, avant-garde, and world cinema.

557. Text and Medium: The Digital Page
The goal of Text and Medium is an understanding of the relationship between the “text” that we generally assume is some kind of “content” and the “medium” that communicates it. The perspective of the seminar is historical and critical. The key assumption is that media—the human voice, manuscripts, books, telegrams, photos, film, TV, paintings, electronic files—shape their “content”—words, pictures, sounds—and 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 can exploit 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 of communication that we cannot yet cross. Students enlist the traditional tools that critics have developed to analyze and understand literary works.

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.

560. Language and Literature in the University 1155 to the Present

Until the twentieth century, the university and its structures, organization, governance, values, approaches to scholarship and understanding were products of an all-male culture. Only recently have scholars begun to re-understand the university in these terms. When language and literature entered the universities, they were conceived within an all-male intellectual tradition that dates back at least to Plato. This course examines how language was conceived, used, and studied in universities and how written literature, always an elite enterprise, came to university attention as mass literacy grew. Today’s subjects of language and literature, now in the hands of ordinary people who have several genders and many languages, have nevertheless retained the values of the traditional male culture through which they entered the university. The course tests the foregoing premise by examining prevailing conceptions of language and of literature.

570. Studies in Twentieth-Century Literature: International Fiction

Readings of examples of twentieth-century fiction from around the world focus students’ inquiry on the representation of imagination. Who imagines what in the influential novels and stories of the past one hundred years? How does the representation of imagination figure into an author’s impact on global culture? In the study of writers who have had a traceable international influence (Borges, Kafka, Beckett, Stein, Woolf, Nabokov, Garcia Marquez, Calvino, Sebald, and Coetzee, among others), this course looks at cross-cultural transmission, effects of translation, and the evolution of fictional form through the last century. Exploration of modern and contemporary imagination theorists include Sartre, Warnock, Scarry, and Kearney.

History

Professors Borus, Brown, Inikori, Kaeuper, Mandala, Outram, Rubin, Slaughter, Weaver, Westbrook
Associate Professors Hudson, Jarvis, Lenoe
Assistant Professors Devaney, Ho, Sierra, Zhang
Joint Appointments: Professors Engerman, Walsh; Associate Professors Beaumont, Gamm, Pedersen
Professors Emeriti Berman, Hauser, Miller, Moore, Waters, Young

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.
405. American Health Policy and Politics
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 mid-1990s.

406. European Cultural History
This course compares different ways of using novels, plays, paintings, poems, and other forms of artistic expression to improve our understanding of the modern European past.

408. Modernity and Modernism
A study of selected topics in the history of modern thought and culture in Europe and the United States.

410. World War II—Eastern Front
This course covers the history of the Soviet Union's struggle with Nazi Germany from 1941 to 1945, the largest and bloodiest military conflict in human history.

412. Ancient Greek Historiography
Examines the craft of ancient Greek historiography by looking at the method, style, and purpose of the ancient Greek historians. Included in the historians studied are Herodotus, Thucydides, Xenophon, Polybius, Arrian, Appian and Cassius Dio.

413. The Power of Print
This course examines the history of books, readers, and literacy in the United States from the colonial period to the present. It explores how the printed word shaped both public events (e.g., the Civil War) and private experience (e.g., relationships within the family).

414. International Human Rights
This course, which begins by exploring the history of British, French, and American debates over the ideal extent of human rights, concludes by considering selected case studies from around the contemporary world.

416. Maritime History of the Atlantic World
This course studies European expansion into Africa and the Americas between the ages of Discovery and Revolution by focusing on the Atlantic Ocean as the geographic center of an expansive network of the maritime connections.

418. Nationalism and Ethnic Conflict in Europe, 1800–2000
This course focuses on the history of European nations as political, economic, and cultural entities, and the challenges to these nations posed by migration, political upheaval, various forms of ethnic identification, and ethnic conflict.

422. Richard Wagner and the Nineteenth Century
This course examines Wagner not only as an artist of lasting significance but also as a figure whose art, ideas, and experience engaged many of the most important issues of the nineteenth and twentieth centuries, including nationalism, revolution, gender relations, anti-semitism, internationalism, progress, myth-making, and history.

423. Stalinism
Course analyzes Stalinism as a social system, focusing on the 1930s.

428. Victorian England
An interdisciplinary seminar on cultural, intellectual, and political history of nineteenth-century England. Topics include industrial revolution, Liberalism and social reform, religion and science, Victorian colonialism, and origins of the First World War.

430. Russia in East Asia
An advanced seminar for students who are familiar with the outlines of twentieth-century international history in East Asia and Europe. Some knowledge of internal Russian and Soviet history is desirable but not required.

433. America and the World I
Introduces students to the historical literature on the global and transnational context of American history from settlement to the Civil War.

434. America and the World II
Continuation of 433. Covers the historical literature that explores the global and transnational context of American history from the Civil War to the late twentieth century.

435. American Thought
Selected topics in American thought, treating the work of intellectuals in its social, political, and cultural context.

438. Modernity through East Asian Eyes
What is Modernity and what does it mean for China, Japan, and Korea.

440. The Black Family in Slavery and Freedom
This course examines the state of the black family in post–Civil Rights America and proffers some policy proposals for a healthier future for the black family.

442. Emergence of the Modern Congress
(Same as PSC 218/518)
Advanced seminar on the history and development of legislative institutions and practices.

443. Race and the American City
This seminar examines the role race has played in defining the physical, cultural, and political environment of American cities in the nineteenth and twentieth centuries.
444. 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.

445. Just Wars
This seminar considers the concept of just war and the application of just war theory to specific historical cases.

447. The Political Economy of Food in Africa
A three-part exploration of the idea that in the world of African peasants, food does not have an independent life apart from the social relations of those who eat it.

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

456. The Atlantic Slave Trade and Africa, 1650–1850
This research seminar examines the Atlantic slave trade, with a particular focus on explaining how and why Africa came to occupy the position it did in the Atlantic economic order, which evolved from the sixteenth century to the mid-nineteenth century.

461. Socioeconomic Development in the Atlantic World
This course is a study in Atlantic World history beginning with a comparative examination of the economic, cultural, and political conditions in the major regions of the Atlantic in the mid-fifteenth century.

465. Modern Jewish History
Seminar examines selected significant topics in modern Jewish history in Europe, the Ottoman Empire/Middle East, and the United States, from the mid-seventeenth century through the twentieth.

473. Sex and Gender in the American City
This course explores the role of gender and sexuality in American cities from the nineteenth century to the present.

482. Topics in the Twentieth-Century American Cultural History
Research seminar on selected topics in modern American cultural history, emphasizing recent scholarship.

484. Urban Change and City Politics
(Same as PSC 241/530)
Examines major issues in the study of city politics, with an emphasis on the American city, present and past.

487. Nation and Culture in Twentieth-Century China
This course focuses on the evolution and expression of Chinese nationalism from the fall of the Qing dynasty (1911) through the Second World War and Communist Revolution (1949).

489. Gender in Late Imperial and Modern China
This course examines problems in the interpretation of gender in the non-Western world with China as the primary historical example. It focuses on the understanding and deployment of gender under a succession of regimes in Chinese history: the Confucian/imperial order, missionary reformism, elite modernization, and state socialism.

491. Directed Readings at the Master’s Level
Individual, specialized reading courses; topics, relevant to student’s program, chosen in consultation with faculty member.

495. Research at the Master’s Level
Credit—to be arranged

496. Extended Studies at the Master’s Level
Credit—to be arranged
Extended reading or research in history at the master’s level.

500. Problems in Historical Analysis
Explores the debates about what historians do and how they do it. Investigates the status of historical truth, diverse methodologies, and the function and purpose of historical work.

501. Topics in Historical Interpretation and Explanation
Acquaints students with the different forms and types of history with a particular emphasis on the worlds of inquiry that characterize Rochester historians. Units on nations, goods, and knowledge.

511. Advanced Historical Studies
Credit—one hour
Investigation of selected topics in history.

512. Advanced Historical Studies
Credit—two hours
Investigation of selected topics in history.

513. Advanced Historical Studies
Credit—three hours
Investigation of selected topics in history.

590. Supervised Teaching in History
Credit—none
Individual instruction in the teaching of history under the supervision of a faculty member. For first-year PhD students.

591. Directed Readings at the PhD Level
Individual, specialized reading courses; topics, directly relevant to student’s program, chosen in consultation with faculty member.
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592. Independent Readings at the PhD Level
Individual readings course pursued independently in consultation with faculty member; topics relevant to student’s program.

593. Assisting in History
Experience, under faculty supervision, in conducting discussion sections and examinations in undergraduate history courses.

595. Research at the PhD Level
Credit—to be arranged

596. Extended Studies at the PhD Level
Credit—to be arranged
Extended reading or research in history at the PhD level.

Linguistics

Professor Carlson
Associate Professors McDonough, Runner (Chair)
Assistant Professor Grimm
Professor Emeritus Moutsos

The Department of Linguistics is dedicated to research and training in the core areas of formal linguistics: syntax, semantics, pragmatics, and phonetics/phonology. The department faculty focus on the empirical and experimental investigation of linguistic phenomena, including experimental syntax, experimental semantics and pragmatics, language corpora, fieldwork, and the neural encoding of speech sounds. Our faculty and students collaborate with faculty and students in other departments with research interests in language including brain and cognitive sciences, computer science, biomedical engineering, and in the Eastman School of Music and Warner School of Education.

The Department of Linguistics offers an MA in linguistics, and participates in programs offering interdisciplinary joint PhD degrees in the cognitive sciences in conjunction with the Departments of Computer Science, Philosophy, and Brain and Cognitive Sciences. For more information, contact the Department of Linguistics.

General

Entering students receive a Department of Linguistics MA student handbook. Students are responsible for knowing their deadlines and keeping track of their progress. Two tracks are available for MA students, Plan A or Plan B. Assignment of students to one track or the other depends on the background of the entering students. Both tracks are designed to prepare students for entry into a PhD program or to provide solid background in formal linguistics for other fields.

Entering students are assigned an advisor(s) and meet with their advisor(s) before the first week of classes to determine their coursework and direction for the immediate semester and year. Entering students may change their advisor in the first term, but after that, it is discouraged.

Primary advisors must be TT faculty or if non-tenure track, the student must have a secondary TT advisor. In this case, coursework and progress must be monitored by both advisors.

Entering students attend a departmental orientation program (two hours) before the first week of classes. All MA students are asked to attend and share information.

All MA students are expected to enroll in any grad seminar that is being taught in a term, unless otherwise exempted. As part of their training, all MA students TA in one course.

At the end of each term, a short report on each student is submitted to the grad program director and reviewed by the faculty. This contains coursework done, progress towards completion, research undertaken, funding, expected finishing date, focus of work, and probable track after graduation.

* Primary appointment in another department
Course Track (Plan B)
This is a two-year program, primarily for students with no background in formal linguistics, to provide them with this background. Students are expected to take core courses in the subfields of linguistics taught in the department, enrolling at the 400 level. Students may take independent studies at the discretion of a faculty advisor.

Requirements for MA (Plan B)
1. Final exam or essay
2. One primary advisor
3. Presentation of thesis to three members of the department (including advisor)

Thesis Track (Plan A)
This track is for students who have some background in linguistics or who plan to work with a particular faculty member or on a particular research project. The relevant coursework is determined in conjunction with their advisor. The expectation is that students in this track are self-motivated and have a research agenda, working with a faculty member to facilitate their progress towards a thesis.

Requirements for MA (Plan A)
1. Thesis committee of two TT faculty and an outside member in the first semester. If a Thesis (Plan A) student wishes to work with a non-TT faculty or a faculty outside the department, this must be vetted by the department faculty.
2. Coursework in consultation with advisor.
3. Thesis submission with a presentation of thesis to the department.
4. Publication in online University of Rochester Working Papers

COURSE OFFERINGS

405. Historical Linguistics
This course is designed to give an introduction to the principles of historical linguistics and their practical application. Topics covered include genetic relations; sound change; borrowing; the comparative method and language classification; types of language contact; morphological, syntactic, and semantic change; and areal linguistics.

408. Language Development Acquisition
(Same as BCS 555)
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.

410. Introduction to Language Sound Systems
Orients students to the principles underlying sound systems in human language. Practice in the production, recognition, and transcription of sounds in various languages of the world, and to the fundamentals of phonological analysis and argumentation through hands-on investigation of language sound systems. Focus in the course is an illustration and documentation of the sound system of a language with data collected from a native speaker in a language of the student’s choice. No background in phonology or phonetics is assumed.

419. Philosophy of Language
(Same as PHL 447)
A study of the philosophical questions about language and the general nature of language.

420. Introduction to Grammatical Systems
This introductory course examines the grammatical structure of sentences from the standpoint of modern linguistic theory. The course develops the basic techniques and concepts of syntactic analysis placing particular emphasis on the ways in which semantic, morphological, and lexical information interacts with the syntax. No syntax background is assumed. This course is intended for majors and non-majors alike.

425. Introduction to Semantic Analysis
This course introduces students to the basic logical notation and techniques used in formal analysis of natural language meaning, primarily in terms of truth-conditions. The course covers the basics of first-order logic and set theory and begins to investigate how meanings represented in these terms correlate with the syntactic and lexical structures of sentences of natural language. Topics include such notions as negation, conjunction and disjunction, plurality, quantification, indexicality, entailment, implicature, and presupposition. Students of graduate standing or those with strong formal backgrounds should consider starting with LIN 265/465 instead, for which this course is ordinarily a prerequisite.

426. Morphology
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 are analyzed and topics such as affixation, reduplication, and inflectional and derivational morphology are covered. Also covered are 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).

427. Topics in Phonetics and Phonology
This course picks up where LIN 410 leaves off, examining research issues in phonetics and phonology. Topics may include speech production and perception, tone and intonation, or rhythm and meter within a broadly defined laboratory phonology approach. The goal of this course is to familiarize students...
with current issues on a given topic through readings and discussion and to design and run an experiment or research project on the semester's topic.

434. Modern English Grammar
Modern English Grammar is a systematic and rigorous survey of the structure of contemporary, general purpose, international Standard English. The course surveys principles governing the construction of English words, phrases, clauses, and sentences, and examines elements of the English spelling system. Throughout, the course pays attention to areas of grammar that commonly come to the attention of writers and learners, with a focus on how an understanding of the systematic nature of the language might yield insight into these and other phenomena.

435. History of the English Language
(Same as ENG 400)
English sounds, inflections, syntax, and vocabulary emphasizing the structure of present-day English.

447. Natural Language Processing
(Same as CSC 247, but requiring a significant project for graduate students)
Prerequisite: CSC 206, CSC 440, or permission of instructor.
Introductory survey of problems involved in constructing computer programs which "understand" natural language and the methods that have been developed to overcome these problems. Solutions to be illustrated by examination of existing computer systems for natural language understanding.

448. Speech Recognition and Statistical Language Processing
(Same as CSC 448, BCS 533)
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.

460. Syntactic Theory
This course picks up where LIN 220/420 leaves off, exploring topics in natural language syntax from a cross-linguistic perspective. The goal of the course is a theory of syntax that accounts for both language-particular as well as universal constraints on language. The orientation is transformational, though lexical perspectives are also explored. Among the topics to be studied are phrase structure, constraints on coreference (binding), the syntactic roles of case, agreement and inflection, thematic roles, long- and short-distance dependencies (extraction and NP movement), constraints on unexpressed phrases (trace and control theory), and quantifier scope.

461. Phrase Structure Grammars
This course picks up where LIN 220/420 leaves off, exploring topics in natural language syntax. The orientation is lexicalist, developing grammatical analyses using Head-driven Phrase Structure Grammar (HSPG) approach, though transformational perspectives are also discussed as points of comparison. By the end of this course, students are able to provide detailed syntactic analyses for highly complex sentences of English; in addition, they acquire the tools to probe the syntactic structures of sentences from any human language.

462. Topics in Experimental Syntax
This course provides an introduction to experimental methods that can be used to investigate questions that are relevant for syntactic theory. The course covers a range of methodologies, including self-paced reading, visual world eye-tracking, magnitude estimation, and questionnaires. During the class, students learn to understand and critically evaluate research that uses various experimental methods and to design and run their own experiments.

465. 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 is helpful but not necessary.

466. Pragmatics
Within theoretical linguistics, pragmatics is (broadly speaking) the study of how language users convey meaning. The concerns of this course fall into three general areas: (1) how meaning carried by linguistic elements (such as sentences) interacts with meaning arising 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 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; anaphora; information structure; speech acts. Emphasis is on developing formal methods and analyses.

467. Topics in Syntax and Semantics
This course examines issues at the interface of syntax and semantics with a concentration on the syntax and semantics of Logical Form (LF). There is a focus on both the developments of LF as a level of representation for the analysis of quantifiers and its current role as an important part of the analysis of language variation within the Principles and Parameters framework. No background in semantics is needed, though some basic syntax (e.g., LIN 420) is assumed.
469. Sign Language Psycholinguistics and Acquisition  
(Same as BCS 569)  
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.

491. Reading Course at the MA Level  
Prerequisite: permission of department.  
Credit to be arranged

495. Research at the MA Level  
Prerequisite: permission of department.  
Credit to be arranged

501. Methods in Linguistic Research (pending school approval)  
An introduction to the field of linguistics and natural language emphasizing a theoretical perspective. Topics cover subfields of linguistics, including phonetics, phonology, morphology, syntax, semantics, and pragmatics.

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

525. Graduate Semantics (pending school approval)  
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 in Phonetics and Phonology  
This seminar focuses on selected topics in phonetic and phonological theory. Past topics include prosody and intonation. For graduate students, postdocs, and faculty in the language sciences.

535. Formal Pragmatics  
Pragmatics, under one conception, is the study of systematic relationships between what linguistic expressions mean and what people mean when they utter such expressions in a particular place, at a particular time, to a particular audience. This course provides an overview of selected topics in the field, including indexicality, Grice and implicature, speech acts and sentence type, information structure, presupposition, and experimental pragmatics. The emphasis on formal pragmatics means that wherever possible, concentration is on theoretical approaches that attempt to model pragmatic effects in a rigorous way, using methods adopted from formal semantics and neighboring fields.

566. Topics in Understanding Language  
This seminar focuses 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.

591. Reading Course at the PhD Level  
Prerequisite: permission of department.  
Credit to be arranged

595. Research at the PhD Level  
Prerequisite: permission of department.  
Credit to be arranged
Mathematics

Professors Cohen, Gage, Gonek, Greenleaf (Chair), Harper, Iosevich, Lubkin, Mueller, Ravenel, Thakur, Tucker
Associate Professors Geba, Jochnowitz, Pakianathan, Salur
Assistant Professors Haessig, Mkrtchyan
Joint Appointments: Professors Rajeev, Shapir

The Department of Mathematics offers the Master of Arts (Plan B), Master of Science in applied mathematics, and Doctor of Philosophy degrees. Applicants are normally assumed 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 two 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 (MTH 590) 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.

All 400-level courses except MTH 463 are offered every year.

436. Algebra I
Prerequisite: MTH 237 or equivalent.
Rings and modules, group theory. Galois theory.

437. Algebra II
Prerequisite: MTH 436.
Multilinear algebra, quadratic forms, simple and semi-simple rings and modules.

440. General Topology
Prerequisite: MTH 265 or equivalent.

443. Algebraic Topology I
Prerequisites: MTH 436 and 440.
The combinatorial structure of complexes and the homology of polyhedra. Application of algebraic techniques in topology to classification of surfaces, fixed point theory, and analysis.

453. Differentiable Manifolds
Prerequisites: MTH 237 and 440.
Differentiable manifolds, mappings and embeddings, exterior differential forms, affine connections, curvature and torsion, Riemannian geometry, introduction to Lie groups and Lie Algebras.

463. Differential Equations
Prerequisite: MTH 472.
Studies the main tools and classes of PDEs.

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

471. Real Analysis
Prerequisite: MTH 265 or equivalent.

472. Functional Analysis
Prerequisite: MTH 471.
491. Reading Course at the Master’s Level
Prerequisite: permission of department.
Credit to be arranged
Special work for master’s degree candidates, arranged individually.
About eight 500-level courses are offered each year depending on
the interests of students and faculty. The following list represents
courses offered in the past several years by members of the present
faculty. Each course carries four hours of credit, or as noted.

503. Theory of Probability
(Same as STT 503)
Prerequisite: MTH 471.
Characteristic functions. The central limit theorem. Infinitely
divisible laws. Random walk on groups.

504. Stochastic Processes
(Same as STT 504)
Prerequisite: MTH 471.
Probability spaces, conditional expectation. Stochastic processes,
separability, limit theorems. Random walk. Markov processes,
invariant measures, semigroups. Probabilistic treatment of poten-
tial theory, compactifications.

506. Advanced Topics in Probability Theory
Topics are related to recent research in the field.

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

535. Commutative Algebra
Prerequisites: MTH 437 and 443.
Field theory, valuations, local rings, affine schemes. Applications
to number theory and geometry.

537. Homology
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 I
Prerequisite: MTH 534, 535, or 536.
Spaces with structure sheaf, schemes, cohomology of schemes,
applications to algebraic curves and algebraic groups.

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

546. Cohomology
Brown’s representability theorem, CW-spectra, and the Atiyah-
Hirzebruch and Adams spectral sequence. The classical spectra
BO, BU, their connective spectra, and the Thom spectra. Applica-
tions to the classical problems of Hopf invariant, vector fields
on spheres, and geometric dimension of vector bundles.

549. Topics in Algebraic Topology
Introduction to research in algebraic topology; course covers:
cup products, fibrations, spectral sequences, and cohomology
operations with particular attention to Eilenberg-MacLane
spaces.

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

556. Topics in Advanced Differential Geometry and Applications
First and second variation of minimal surfaces; rigidity; com-
parison theorems; calculus of variations in the large.

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

562. Fourier Series
Prerequisite: MTH 471.
Fourier and Fourier-Stieltjes transforms. Convergence and summa-
bility theorems. Transforms in Lp. Riesz’s convexity theorem. Men-
shov’s theorem. Conjugate series. Introduction to Fourier integrals.

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

568. Topics in Number Theory
Prerequisite: none.
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
Prerequisites: MTH 467 and 230 or equivalent.
Selected topics in non-multiplicative analytic number theory
considered on a seminar basis.

578. Topics in Harmonic Analysis
A survey of modern Fourier analysis. Summability of Fourier
series and transforms. Restriction theorems for the Fourier trans-
form. Estimates for oscillatory integrals and oscillatory integral
operators. Combinatorial techniques.
Supervised College Teaching
Credit—none
One classroom hour per week of discussion and problem solving with a small group of University of Rochester students, under the guidance of a member of the faculty.

Reading Course at the PhD Level
Prerequisite: permission of department.
Credit to be arranged
Special work for doctoral candidates, arranged individually.

Research at the PhD Level
Credit to be arranged

Seminar
Prerequisite: permission of department.
Credit to be arranged
For doctoral candidates; topics to be selected.

Mathematics Colloquium
Credit—none
Weekly lectures by invited speakers on topics of current interest in mathematical research. Required of all students who have completed one year of graduate study.

Philosophy
Professors Conee, Curren (Chair), Feldman, FitzPatrick, Modrak
Associate Professors Dees, Ney
Assistant Professors Peterman, Sherman, Weslake
Joint Appointments: Professors Carlson, Wierenga
Professors Emeriti Eberle, Holmes, Meerbote, O’Brien

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.

All courses carry four credit hours unless otherwise noted.

Logical Methods in Philosophy
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.

Intermediate Logic
Prerequisite: PHL 110 or equivalent.

Mathematical Logic
Prerequisite: PHL 110 or equivalent.
Computability, incompleteness of arithmetic, metatheory of propositional and predicate logic.

Uncertain Inference
(Same as CSC 417)
Prerequisite: PHL 110 or equivalent.
The exploration of various measures of uncertainty proposed in both philosophy and computer science.
418. Philosophy of Mathematics  
Prerequisite: PHL 110 or equivalent.  
A study of the nature of mathematics from a philosophical point of view.

419. Deviant Logic  
Prerequisite: PHL 110 or equivalent.  
The study of “alternative” logics: logics in which more than two truth values are possible, logics designed to accommodate vagueness, logics that allow inconsistencies.

420. Recent Ethical Theory  
Prerequisite: PHL 102 or permission of instructor.  
An examination of the main twentieth-century ethical and metaethical theories.

421. Philosophical Foundations of the American Revolution  
Prerequisite: one previous course in philosophy or permission of instructor.  
An examination of the political theory which lies behind the Revolution itself and which underlies the foundations of the Constitution.

422. Social and 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.

423. History of Ethics  
Prerequisite: one previous course in philosophy.  
An examination of the major writers on ethics in Western thought, including Plato, Aristotle, Aurelius, Augustine, Hume, Kant, Mill, and Nietzsche.

424. Philosophy of Law  
Prerequisite: one previous course in philosophy.  
The nature of law and legal practice in relation to ethics.

425. Public Health Ethics  
Prerequisite: one previous course in philosophy.  
This course examines the values of health, social needs, and freedom through a systematic examination of situations in which these conflicts arise.

426. Philosophy of Education  
Prerequisite: one previous course in philosophy.  
Addresses a variety of philosophical and policy debates about education, using selections from philosophical classics and contemporary readings.

430. Environmental Justice  
Prerequisite: one previous course in philosophy.  
Considers environmental problems and the distribution of environmental resources and burdens from the standpoint of ethics and political philosophy.

442. Metaphysics  
Prerequisite: one previous course in philosophy.  
A survey of a few recent metaphysical controversies, concerning topics such as free will, the nature of mental states, the existence of universals, and personal identity.

443. Theory of Knowledge  
Prerequisite: one previous course in philosophy.  
Nature and extent of human knowledge. What is knowledge? Can skepticism be refuted? Under what conditions are beliefs justified or rational? Can anyone know what is right and wrong?

444. Philosophy of Mind  
Prerequisite: one previous course in philosophy.  
A discussion of the nature of mind and mental states.

447. Philosophy of Language  
Prerequisite: one previous course in philosophy.  
A study of philosophical questions about language and the general nature of language.

449. Formal Semantics  
Prerequisite: one previous course in philosophy.  
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.

451. Philosophy of Biology  
Prerequisite: PHL 110 or permission of instructor.  
An introduction to philosophy of biology focusing on issues connected with the nature and scope of biological explanations.

454. Philosophy of Cognitive Science  
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.

460. Contemporary Issues in Philosophical Theology  
A philosophical examination of such theological concepts as original sin, atonement, incarnation, and trinity.
461. Kant
Prerequisite: PHL 202.
A study of the philosophy of Immanuel Kant focusing on the Critique of Pure Reason. The course also pays some attention to several issues in Kant’s practical and moral philosophy such as his account of volition and the free-will problem.

465. Selected Topics in Ancient Greek Philosophy
Prerequisite: PHL 201 or permission of instructor.
A topical approach to the study of philosophy of the Presocratics, Plato, Aristotle, Epicurus, the Stoics, and the Hellenistic skeptics.

466. Rationalism
Prerequisite: PHL 202.
The study of three great philosophical figures of the rationalist period: Descartes, Leibniz, and Spinoza, with emphasis on the latter. Topics include the nature of substance, of space and time, and of knowledge and mind.

467. British Empiricism
Prerequisite: PHL 202.
Studies in the philosophy of Locke, Hume, and Reid. Topics include theories of knowledge, consciousness, space, and perception.

468. Augustine, Anselm, and Aquinas
Critical examination of the writings of these important philosophers/theologians, with particular attention to their views that are relevant to the philosophy of religion.

469. The Origins of Analytic Philosophy
A study of the origins and development of the analytic tradition in philosophy through the writings of Frege, Russell, and the early Wittgenstein. The focus of the course is on their views on logic, language, mathematics, and the nature of philosophy.

502. Selected Topics in the Theory of Knowledge
503. Selected Topics in History of Philosophy I
504. Selected Topics in History of Philosophy II
505. Semantics
506. Selected Topics in Logical Theory
507. British Empiricism
508. Probability and Induction
509. Decision Theory
510. Selected Topics in the Theory of Value
514. Selected Topics in Ancient Philosophy
515. Selected Topics in the Philosophy of Mind
516. Selected Topics in the Philosophy of Language
517. Selected Topics in Ethics
518. Selected Topics in Moral Philosophy
519. Selected Topics in History of Modern Philosophy
520. Selected Topics in Political Philosophy
521. Aristotle
522. Plato
526. Theories of Justice
527. Berkeley
529. Rationalism and Empiricism
530. Kant I
531. Kant II
541. Aesthetics
542. Selected Topics in Metaphysics
552. Selected Topics in History and Philosophy of Science
560. Writing Seminar
Study of recent articles; writing short commentaries, replies, criticisms. Covers various topics under guidance of several faculty members.

565. Selected Topics in the Philosophy of Religion
571. Philosophy of Cognitive Science
580. Supervised Instruction in Philosophy
Supervised teaching of undergraduates, including leading discussion sections, grading tests and papers, and meeting with students.

581. Supervised Instruction in Philosophy
Continuation of PHL 580, with practice lecturing to the undergraduate classes.
591. Reading Course at the PhD Level  
*Credit to be arranged*

Reading and analysis of philosophical literature on an advanced level, under supervision of one or more faculty members; written and oral reports.

595. Research at the PhD Level  
*Credit—varies*

999. Writing Dissertation in Residence  
*Credit—none*

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**Physics and Astronomy**

Professors Bigelow, Blackman, Bodek, Cline, Das, Demina, Douglass, Eberly, Ferbel, Forrest, Frank, Gao, Hagen, Howell, Manly, McFarland, Melissinos, Orr, Quillen, Rajeev, Shapir, Slattery, Teitel, Thorndike, Watson *(Chair)*, Wolf, Wolfs Professor (Research) Duke, Knight, Milloni  
Associate Professors Jordan, Mamjek  
Assistant Professors Badolato, Ben-Zvi, Garcia-Bellido  
Senior Scientists Budd, deBarbaro, Ginther, Sakamoto, Zelinski  
Visiting Senior Scientists Harris, Skulski  
Visiting Scientist Carroll  
Adjunct Senior Research Associate Hioe  
Joint Appointments: Professors Agrawal, Betti, Bocko, Boyd, Foster, Guo, Knox, McCrory, Meyerhofer, Prezhdo, Rothberg, Schröder, Sobolewski, Stroud, Tarduno, Thomas, Zhong;  
Associate Professors Dery, Ren; Assistant Professor Froula  
Visiting Professors Franklin, Visser  
Professors Emeriti Castner, Helfer, Knox, Okubo, Pipher, Savedoff, Simon, Van Horn

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 paleomagnetism 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 ultracold 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, with preference given to candidates for the PhD degree. 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), two courses in quantum mechanics (407, 408), 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 written preliminary examination is usually taken at the
beginning of the second year of study, and 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 pre-
sentation 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 undergradu-
ate 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 regu-
larly, and constitute an important component of graduate education.

The department offers a BS-MS program in physics and
physics and astronomy. Students who wish to go beyond the bachelor’s level may enroll in the department’s five-year BS-MS
program. Students are encouraged to apply to the program in
the spring of the junior year and can begin graduate-level work
in the fourth year. The BS is completed by the end of the fourth
year, and requirements for the MS are completed by the end of
the fifth year. The MS degree may be pursued via plan A (with
master’s thesis) or plan B (with comprehensive exam).

### PHYSICS

**401. Mathematical Methods in Optics and Physics**  
*Same as OPT 411*  
Prerequisites: MTH 164, 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.

**403. Modern Statistics and Exploration of Large Data Sets**

Probability. Inference and hypothesis testing. Special probability

**405. Geometric Methods of Physics**  
Prerequisite: MTH 243 or equivalent.

Riemannian Manifolds. Applications.

**406. Symmetries in Physics**  
Prerequisites: PHY 401, 404, or equivalent.

Finite groups. Compact and non-compact Lie groups and Lie
algebras. Group representation theory.

**407. Quantum Mechanics I**

Quantum-mechanical axioms. Probability densities and currents.
Boson representations of the oscillator. Angular momentum
including Clebsch-Gordan coupling, spherical tensors, finite
rotations, and applications to atoms and nuclei. Simple gauge
transformations. Aharonov-Bohm effect. Bell’s theorem. The
SO(4) treatment of the hydrogen atom.

**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.

**411. Mechanics and Chaotic Dynamics**  
Prerequisite: PHY 235.

Lagrangian and Hamiltonian dynamics, canonical transforma-
tions, Hamilton-Jacobi equations, chaotic dynamics and routes
to chaos, Fourier spectrum and Poincaré maps, Lyapunov ex-
ponents, strange attractors and fractal dimensions, information
dimension and Kolmogorov entropy, numerical tests for chaotic
behavior.

**412. Computational Methods for Engineering and Science**  
Prerequisite: ME 402 or PHY 401 or OPT 411, or permission of the
instructor. Some FORTRAN experience desirable.

Computational solutions to coupled nonlinear partial differen-
tial equations arising in engineering and physics. Emphasis on
current problems and techniques.

**413. Gravitation**

Motivation for a metric theory of gravity, principle of equiva-
ience, principle of general covariance, mathematical tools,
curvature tensor, Einstein field equations and solutions, energy
momentum tensor, weak field approximation, applications, and
optional topics.
415. Electromagnetic Theory I
Prerequisite: PHY 401 or may be taken concurrently.

420. Introduction to Condensed Matter Physics
(Same as PHY 251, ECE 420)
An emphasis is made 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.

428. Physics of Radiobiology II

429. Organic Electronics

431. Nano-optics
(Same as OPT 463)
Prerequisites: advanced calculus and vector analysis, electromagnetic theory (OPT 462 or equivalent), and quantum mechanics (OPT 412 or equivalent).
Nanooptics 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. Further topics are optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single-molecule spectroscopy, light forces and optical trapping, theoretical methods in nano-optics.

434. Quantum Optics and Quantum Information Laboratory
An advanced optics teaching laboratory course that exposes the cutting-edge photon counting instrumentation and methods with applications ranging from quantum information to biotechnology and medicine.

435. Laser Systems
(Same as OPT 465)
The design and use of laser systems, emphasizing visible and near-infrared lasers. The course is engineering oriented and covers techniques for measuring laser characteristics as well as a variety of laser applications. An introduction to nonlinear optics is included.

436. Molecular Spectroscopy and Structure
(Same as CHM 458)
The course covers the theory and experimental practice of spectroscopic methods used to study molecules in both gas and condensed phase with an emphasis on the latter.

437. Nonlinear Optics
(Same as OPT 467)
Fundamentals and applications of optical systems based on the nonlinear interaction of light with matter. Topics 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.

438. Optical Communication Systems
(Same as OPT 428)
Designed to give students a basic understanding of the optical communications systems while making them aware of the recent technological advances. The following topics are covered: components of an optical communication system; propagation characteristics of optical fibers; lightwave sources such as light-emitting diodes and semiconductor lasers; optical receivers; noise analysis and bit-error rate; coherent, multichannel, and soliton-based communication systems.

439. Nonlinear Optical Spectroscopy
(Same as CHM 459, OPT 459)
Covers a broad range of optical spectroscopic techniques and focuses 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 is developed. The relationships between ultrafast (time-domain) and frequency-domain techniques are discussed. Applications are 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 are discussed.

440. Twentieth-Century Particle Physics
(Same as PHY 254)
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.

445. Advanced Nuclear Science Education Laboratory (ANSEL)
The course focuses on a sophisticated understanding of our terrestrial radiation environment and of some of the important applications of nuclear science and technology. The course covers practical skills in the routine use of radiation detectors, monitors, and electronics, and strengthens the ability to assess radiation threats and prospects of their abatement.

446. Nuclear Science and Technology I
(Same as CHM 466)
The course covers the microscopic structure of nuclei and the dynamics of nuclear collisions; the interaction of nuclear radiation with matter, techniques and applications of radiation detectors, gross properties of nuclei and their structure (shell and collective models), gamma and particle decay of unstable nuclei, nuclear forces and their symmetries, nuclear scattering and reactions, potential scattering, nuclear fusion, and particle transfer.

451. The Physics of Astrophysics I: Radiative Processes
(Same as AST 461)
Prerequisites: PHY 407, 408, 415, 418 in the past or concurrently.
Focuses on the physics of radiation production by ionized and atomic matter, the transfer of radiation through matter, and what is measured from astrophysical objects.

452. The Physics of Astrophysics II: Astrophysical Fluids and Plasmas
(Same as AST 462)
Focuses on hydrodynamic and plasma processes relevant to astrophysics. Fundamentals of fluid dynamics and magnetohydrodynamics, fluid, MHD, thermal instabilities, turbulence, supersonic and subsonic flow. Accretion physics, shocks, dynamos, particle accelerations in plasmas, dynamics of magnetic fields.

454. Introduction to Plasma Physics I
(Same as ME 434)
Orbit theory, adiabatic invariants, MHD equations, waves in plasma, shock waves in plasma, and diffusion across magnetic fields and in velocity space.

455. Introduction to Plasma Physics II
(Same as ME 435)
Prerequisite: PHY 454 or permission of instructor.
Continuation of PHY 454. Vlasov equation, Landau damping, VanKampen modes, shield clouds, two-stream instability, microinstabilities, drift instability, and nonlinear instability theory radiation from plasma.

456. Compressible Flow
(Same as ME 436)
Prerequisites: ME 225 and 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.

457. Incompressible Flow
(Same as ME 437)
Kinematics, the Navier-Stokes equation, the stream function, vorticity dynamics, laminar viscous flows, slow viscous flow boundary layers, inviscid irrotational flow.

458. Geometric Methods in Incompressible Flow and Turbulence
This course focuses on applying methods of Riemannian geometry to fluid mechanics. At an elementary level, it involves using curvilinear coordinates 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 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 are also studied this way.

462. Medical Imaging Theory and Implementation
(Same as ECE 452, OPT 452, BME 452)
Prerequisite: ECE 242.
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
(Same as PHY 253)
Physical aspects of special topics in biology. The purpose of this course is to survey several important areas of biological and medical physics. Topics 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.

475. Experimental Particle Physics
Prerequisite: permission of instructor.
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. (Summer)

491. Reading Course at the Master’s Level
Credit to be arranged
Special study or work, arranged individually for master’s candidates.

492. Certificate in Teaching of College Physics or Physics and Astronomy
Prerequisites: PHY 498, 499, 597 or 598, 599.
After serving as lead teaching assistants (TA), students teach a course during the University’s summer session. Students successfully completing the graduate teaching program are awarded a Certificate of College Teaching in Physics and Astronomy.

493. Special Topics in Physics I
Subject matter to be selected by instructor and students on an ad hoc basis in specific areas at the master’s level.

494. Special Topics in Physics II
Subject matter to be selected by instructor and students on an ad hoc basis in specific areas at the master’s level.

495. Research in Physics (MS)
Independent investigation leading toward a master’s thesis carried out under the supervision of a staff member.

498. Supervised Teaching Assistant I
Credit—none
Designed for students to be laboratory or recitation teaching assistants (TA). Typically, students spend the semester teaching two laboratories during the fall semester for the introductory physics and astronomy courses.

499. Supervised Teaching Assistant II
Prerequisite: PHY 498
Credit—none
A follow-up course of PHY 498. Students, experienced laboratory and recitation leaders, serve as lead teaching assistants (TA). Students spend the semester teaching two laboratories during the spring semester for the introductory physics and astronomy courses.

509. Introduction to Nonrelativistic Many-Body Systems
Prerequisites: PHY 407, 408, or equivalent.
The basic concepts and techniques of many body systems and how they are used to extract physical properties. Techniques covered are second quantizations, 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.

510. Advanced Quantum Mechanics (Relativistic)
Prerequisite: PHY 509.
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.

511. Field Theory
Prerequisites: PHY 509 or 510.
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 theories. 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.

512. Renormalization
Prerequisites: PHY 509 or 510.
Background and introduction to renormalization, one-loop divergences in perturbation theory, and Callan Symanzik equation. The renormalization group and Wilson’s point of view, effective actions, and operator product expansion.

513. Magnetic Resonance Imaging: From Spins to Brains
(Same as BCS 513, BME 513, NSC 513)
Prerequisite: PHY 422 or ECE 452.
Course introduces students to the physics of MR imaging and reviews its application to medical imaging. Discusses how the MR technique can take advantage of physiological principles and tissue structure to provide diagnostic images for clinicians and researchers. Covers what can be learned about brain functions through MR imaging. Introduces functional brain imaging and related issues in data analysis.

516. Electromagnetic Theory II
Prerequisites: PHY 401 and 415; may be taken concurrently.
A continuation of PHY 415 covering special topics, such as physical optics, radiation from moving charges, radiation damping, scattering and electrodynamics in material media.

519. Statistical Mechanics II
Prerequisites: PHY 402, 408, 418.
A continuation of PHY 418, involving the theory of imperfect gases, phase transitions, and Brownian motion.

521. Condensed Matter I
(Same as MSC 550)
Prerequisites: PHY 407, 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.
522. Condensed Matter II
(Same 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. Special Topics in Condensed Matter
Prerequisites: PHY 521 and 522 or permission of instructor.
Subject matter to be selected by the instructor from among topics of current interest in solid-state physics.

524. Special Topics in Condensed Matter
(Same as MSC 552)
Prerequisites: PHY 521 and 522 or permission of instructor.
Subject matter to be selected by the instructor from among topics of current interest in solid-state physics.

527. Introduction to Computational Neuroscience
Prerequisite: BCS 512 recommended.
Review various computational theories of how the brain encodes, selects, and represents behaviorally relevant variables, computes over these variables, and modifies its circuitry as a result of experience.

531. Introduction to Quantum Optics
(Same as OPT 551)
Prerequisites: PHY 401, 402, 407, 408, 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.

532. Quantum Optics of the Electromagnetic Field
(Same as OPT 552)
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.

533. Quantum Optics of the Atom-Field Interaction
(Same as OPT 553)
Prerequisites: PHY 531, 532.
Subject matter to be selected from topics of current interest in quantum optics.

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, 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.

536. Special Topics in Quantum Optics
(Same as OPT 556)
Prerequisites: PHY 531, 532 or permission of instructor.
The instructor chooses a topic of current interest in quantum optics.

537. Statistical Optics
(Same as OPT 563)
Prerequisites: OPT 461 and OPT 462; students are encouraged to take PHY 404 concurrently.
Topics include elements of applied probability theory: probability theory, random variables, moments of random variables, density and distribution functions, characteristic and moment generating functions, and the central-limit theorem. Introduction to stochastic process: stationarity and ergodicity, correlation functions, power or Wiener spectrum, Gaussian processes, Poisson point processes, compound Poisson point processes. Coherence theory of optical fields, Laser speckle and its applications, photoelectric detection of light.

538. Advanced Topics in Light-Wave Technologies
(Same as OPT 528)
Prerequisite: OPT 461; OPT 428 recommended, but not required.
Course is designed to provide students with understanding of the recent advances in the field of light-wave technology. Topics include background material, fiber Bragg gratings, fiber couplers, fiber interferometers, fiber amplifiers, fiber lasers, pulse compression, fiber-optic communication, optical solitons.

539. Waveguide Optoelectronic Devices
(Same as OPT 568)
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.

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.

542. Nuclear Structure II
Prerequisite: PHY 541.
Electromagnetic and weak transitions; sum rules, introduction to nuclear reactions, theory of nuclear forces.

544. Special Topics in Nuclear Physics
Prerequisites: PHY 541, 542.
Subject matter to be selected from among advanced topics in the theory of nuclear structure and nuclear reactions.

546. Nuclear Science and Technology II (Nuclear Chemistry II)
(Same as CHM 566)
Prerequisites: PHY 446/CHM 466.
Experimental and theoretical studies of heavy-ion scattering and reaction mechanisms; semiclassical and quantum scattering theory; Coulomb excitation; few-nucleon transfer; damped heavy-ion reactions; fusion and fission processes; statistical approaches to complex nuclear reaction mechanisms.

552. Magnetohydrodynamics
(Same as ME 532)
Equations of magnetohydrodynamics. Kinematical theory of magnetic field transport; equilibrium and stability; incompressible MHD flows; magnetoacoustic waves; MHD shock waves. Kinetic theory foundations of MHD and selected applications, such as flowmeters, the dynamo problem, solar wind, and sunspots.

553. Laser-Plasma Interactions
(Same as ME 535)
Prerequisite: PHY 426 or permission of instructor.

554. Cosmology
(Same as AST 554)
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.

555. Advanced Topics in Plasma Physics
(Same as ME 545)
Course varies year to year. Topics include controlled fusion reactor concepts, including laser fusion, energy in the future, space plasmas, and astrophysical plasma phenomena.

556. Hydrodynamic Stability and Turbulence
(Same as AST 554)

557. Plasma Stability
(Same as ME 534)
Prerequisite: ME 434 or permission of the instructor.
Stability of magnetically confined plasma, delta-W formalism, double adiabatic equation, comparison theorem, shear stabilization, minimum-beta fields, resistive instabilities, Tokamak and Mirror stability theory.

558. Inertial Confinement Fusion
(Same as ME 533)

564. High-Energy Astrophysics
(Same as AST 564)
Prerequisite: AST 461, 462.
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.

573. Physics and Finance
Prerequisite: PHY 227 or equivalent (can be taken concurrently) or instructor’s permission.
Introduction to econophysics and the application of statistical physics models to financial markets. Parallels between physical and financial phenomena are emphasized. Topics include random walks and Brownian motion, introduction to financial markets and efficient market theory, asset pricing, and the Black-Scholes equation for pricing options. Non-Gaussian Levy processes and the applicability of power law distributions and scaling to finance.

581. Particle Physics I
Prerequisites: PHY 408, PHY 509 concurrently.
582. Particle Physics II  
Prerequisite: PHY 509.
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.

584. Special Topics in Particle Physics  
Prerequisite: PHY 582.
Subject matter to be selected from topics of current interest in particle physics.

591. Reading Course at the PhD Level  
Credit to be arranged
Special study or work, arranged individually.

593. Special Topics in Physics I  
Subject matter to be selected from among advanced topics of current interest. Course has separate sections dealing with diverse topics.

594. Special Topics in Physics II  
See PHY 593, which is not prerequisite.

595. Research at the PhD Level  
Credit to be arranged
Independent investigation leading toward a doctoral thesis carried out under the supervision of a staff member.

597. Graduate Teaching and Research Seminar  
Credit—none
Course given once per week, required of all first-year graduate students. Consists of lectures and discussions on various aspects of being an effective teaching assistant, including interactions with undergraduate student body and cross-cultural issues. Faculty members discuss topics in their current area of research interest.

598. Teaching Workshop Leader Pedagogy Training  
Credit—none
Designed for Workshop Leader teaching assistants (TA). Typically, TAs attend weekly Workshop Leader training meetings that offer specialized support and training in group dynamics, learning theory, and science pedagogy for students facilitat- ing collaborative learning groups for science and social science courses. TAs teach three to four workshops in one of the fall semester introductory physics courses.

599. Pedagogy and Group Leadership  
Prerequisite: PHY 598.  
Credit—none
Designed as a follow-up course for an experienced Workshop Leader. TAs typically attend weekly Workshop Leader training meetings that offer specialized support and training to develop leadership skills, foster ongoing communication among faculty members and study group leaders, and provide review of study group–related issues. Students spend semester teaching three to four workshops during the spring semester introductory physics courses.

999. Doctoral Dissertation  
Credit—none
Writing dissertation.

ASTRONOMY

403. Experimental Techniques in Astronomy  
Prerequisites: the equivalent of PHY 217–218, ME 201, and PHY 227.
Introduction to the tools of modern observational astronomy. Discussions of geometrical and physical optics applied to telescopes and astronomical cameras; the physics of light detection at radio, infrared, visible, X-ray, and g-ray wavelengths; and the instruments and techniques used for observations of faint celestial objects over the full 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 407–408 and 418, in the past or concurrently.

453. Introduction to Stellar Interiors and Stellar Atmospheres  
Prerequisites: PHY 407–408, 418, in the past or concurrently.
A first course on stellar interiors and atmospheres in which approximately 50 percent of a semester is devoted to each. See AST 450 and 553 for full-fledged courses.

455. Astronomical Interferometry  
Prerequisites: AST 403, PHY 415.
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. The Physics of Astrophysics I: Radiative Processes  
Prerequisites: PHY 407–408, 415, 418, in the past or concurrently.  
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.

462. The Physics of Astrophysics II: Astrophysical Fluids and Plasmas  
(Same as PHY 452)  
Focuses on hydrodynamic and plasma processes relevant to astrophysics. Fundamentals of fluid dynamics and magnetohydrodynamics, fluid, MHD, thermal instabilities, turbulence, supersonic and subsonic flow. Accretion physics, shocks, dynamos, particle accelerations in plasmas, dynamics of magnetic fields.

465. Observational Galactic Structure  
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.

495. MS Research in Astrophysics  
Independent investigation leading toward a master’s thesis carried out under the supervision of a staff member.

553. Stellar Interiors  
Prerequisite: AST 461–462 or AST 453.  

554. Cosmology  
(Same as PHY 554)  
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.

563. Seminar on Radio 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.

564. High Energy Astrophysics  
(Same as PHY 564)  
Prerequisites: AST 461, 462.  
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.

565. Formation of Stars and Planetary Systems  
Prerequisites: PHY 235, 227, AST 241 (AST 461 and 462 are helpful), or permission of instructor.  
Survey of theory and multiwavelength 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.

570. Solar System Dynamics  
Dynamics of bodies in the solar system and exosolar systems are explored with an emphasis on applying results to the interpretation of exoplanetary systems. Topics covered are two-body problem, orbital elements, f and g functions, universal variables for hyperbolic and eccentric orbits. Hamiltonian formulation, canonical transformations, symplectic integrators, hyperbolic orbits, impulse approximations, dynamical friction, gravitational stirring, three-body problem, Jacobi integral, Tisserand relation, disturbing function, low eccentricity expansions, secular perturbations, mean motion resonances, resonant trapping, dust dynamics, Yarkosky effect.

591. Reading Course at the PhD Level  
Credit to be arranged  
Special study or work, arranged individually.

595. Research at the PhD Level  
Credit to be arranged  
Independent investigation leading toward a thesis carried out under the supervision of a staff member.

999. Doctoral Dissertation  
Credit—none  
Writing dissertation.
Political Science

Professors Duggan, Jackson, Jacobs, Johnson, Niemi, G. Powell, L. Powell, Rothenberg, Seligman, Stone
Associate Professors Clarke, Fey, Gamm, Helmke (Chair), Goemans, Kalandrakis, Meguid, Primo, Signorino
Assistant Professors Acharya, Jordan, Lacina, Peress
Professors Emeriti Bluhm, Fenno, Phelps, Regenstreif

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, 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. The PhD comprehensive examinations in 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 serve 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 and 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 nonexperimental 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 econometric 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

This course examines 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

This course is the first half of a two-course sequence consisting of PSC 407 and 408. The goal of the sequence is to give a rigorous introduction to the main concepts and results in positive political theory. At the same time, students are taught the mathematical tools necessary to understand these results, to use them, and how to surpass them in their own research in political science. The course emphasizes rigorous logical and deductive reasoning—this skill proves valuable, even to the student primarily interested in empirical analysis rather than modeling. The sequence is designed to be both a rigorous foundation for students planning on taking further courses in the positive political theory field and a self-contained overview of the field for students who do not intend to do additional coursework in the field. The sequence covers both social choice theory, which concerns finding an axiomatic basis for collective decision making, and game theory, which analyzes individual behavior in strategic situations. Students gain, at a minimum, a sound familiarity with basic algebra (solving equations, graphing functions, etc.) and a knowledge of basic calculus. Consistent with department policy, students are required to attend the “math” camp offered in the weeks before the first fall semester.

408. Positive Political Theory

This course is part of a rigorous introduction to the main concepts and results in positive political theory. It is the second half of a two-course sequence consisting of PSC 407 and 408. This course focuses on the basics of game theory, which analyzes individual behavior in strategic situations. It also covers the mathematical tools required to express the theory. Examples and applications will be drawn from several different areas in political science, including the U.S. Congress, voting, international relations, political economy, and law.

465. Civil War and the International System

Civil war is by far the most common form of armed conflict in the contemporary world. Internal wars, such as those in Iraq and Afghanistan, are also central to the major foreign policy debates...
in the United States and the United Nations. The first half of this course addresses the question of when and where civil wars occur and what their effects are domestically and internationally. The second half of the class examines external actors’ role in civil war, such as financial support to governments or insurgents, armed interventions, and peacekeeping missions. Students are evaluated based on two midterms and a final.

471. Russia and Eastern Europe: Politics and International Relations

For the small countries of Eastern Europe, politics has always taken place in the shadow of larger actors and continues to be decisively influenced by events beyond national borders. Meanwhile, the dramatic shifts in international affairs in the last century had their origins in domestic upheavals, often in Russia. The course surveys the politics and international relations of the region in the second half of the twentieth century, devoting roughly equal attention to the Cold War and post–Cold War periods. (Every 2–3 years)

479. War and 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. Students examine the phenomenon of war in its broader socioeconomic context, focusing on nationalism, bureaucratization, industrialization, and democratization. The course goes 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 makes a presentation in class on the readings for one class (25 percent of the grade), and there will be one big final (75 percent). (Every 2–3 years)

480. Scope of Political Science

The aim of the seminar is to encourage students to examine political science in a reflective, disciplined, critical way. It is primarily designed for entering PhD students but may be appropriate for undergraduate seniors considering graduate work in political science. We use 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.

482. Art and Politics

This course on the interactions between art and politics in the twentieth century is conducted as an intensive and advanced seminar. Drawing on art history, literature, and political theory, the course explores the ways that politics and the practices of artistic representation intersect. Much of the course treats questions of race and identity. The focus primarily includes French and American examples, including but not limited to the representation and theorization of torture, forced migration, lynching, globalization, and racial categories. Students are expected to look at art, read poetry and literary texts, analyze and understand political theory, and participate in a series of speakers and symposia outside of the class. This course is designed for students from across the humanities and the social sciences. (Rarely)

484. Democratic Theory

This advanced course in political theory focuses on various topics in democratic theory such as the relation between democracy and other basic political principles (liberty, equality, justice); whether democratic institutions should best be aggregative or deliberative; and the role of referenda, lotteries, and new telecommunications technology in democratic decision making. Readings are drawn from both advocates and critics of democratic politics and encompass historical and contemporary theorists. The class format combines lecture and discussion. (Rarely)

487. Theories of Political Economy

In recent decades a number of important intellectual intersections have emerged between political science and economics. The course explores these intersections as they appear in the work of several scholars who have won the Nobel Prize in economics. The 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. Some prior coursework in economics or political science is helpful but is not required.

502. Political and Economic Networks

Social networks pervade political and economic life. They shape how we acquire political knowledge, how we discover job opportunities, and how we shape and maintain norms. The multitude of ways that networks affect the world makes it critical to understand how network structures impact behavior, which network structures are likely to emerge, and why we organize ourselves as we do. Drawing on a wide variety of fields, this course reviews the literature, both theoretical and empirical, on social, economic, and political networks. Topics include basic network structures, network formation, games on networks, learning, diffusion, and methods for network analysis.

503. Formal Modeling in Comparative Politics

Comparative politics is concerned with a variety of questions. For example: What are the consequences of different political institutions on various outcomes? What are the causes and motivations for mass political movements, and what is the mechanism by which they are organized? What are the political causes of underdevelopment? How are identities created, and what role do they play in politics? Why are redistribution and the size of government greater in some countries than others? And many other questions are addressed using formal models. This course is designed to provide students with the skills to develop their own models for answering these and related questions. The course begins with a brief review of established modeling techniques and then studies particular models that have been developed by the previous literature in comparative political economy. The course concludes by discussing new modeling techniques and their relevance for comparative politics. (Rarely)
504. Causal Inference

Substantive questions in empirical social science research are often causal. Does voter outreach increase turnout? Do political institutions affect economic development? Are job-training programs effective? This class introduces students to both the theory and the practice behind making these kinds of causal inferences. The course covers causal identification, potential outcomes, experiments, matching, regression, difference-in-differences, instrumental variables estimation, regression discontinuity designs, sensitivity analysis, dynamic causal inference, and more. The course draws upon examples from political science, economics, sociology, public health, and public policy.

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 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 is to teach students how to develop new models and techniques for analyzing issues they encounter in their own research.

506. Advanced Topics in Methods

Prerequisites: PSC 404, 405, and PSC 505.

This course is designed for graduate students intending to pursue political methodology as a major field. It covers advanced statistical methods that are not yet standard fare in political methodology courses: e.g., semiparametric methods, nonparametric regression, time-series econometrics, Bayesian methods, and ideal point estimation. Course content varies year to year; some semesters focus more heavily on Bayesian methods, simulation-based estimation, and ideal point estimation. As a research workshop, this course also allows students to pursue areas of individual interest in more depth, and, therefore, course content is determined based on the interests of both the professor and the students. (Every other year)

507. Computational Methods

This class is an introduction to computational methods with particular emphasis on applying these techniques in methods and formal theory. Being on the cutting edge of political methodology and formal theory increasingly requires detailed knowledge of computational techniques. The course covers such topics as numerical differentiation and integration, simulation methods, numerical linear algebra, numerical optimization, computation of equilibria, and various other topics. Each of these techniques is applied to a number of core applications: Bayesian estimation, estimation using the Simulated Method of Moments, nonparametric estimation, multiplayer games, dynamic optimization problems, and structural estimation. (Every other year)


Prerequisites: students must have taken the equivalent of PSC 404, 405, 505, have some familiarity with nonparametric and semiparametric methods, and have taken a graduate course in noncooperative game theory.

Scholars of political science, economics, and business are increasingly interested in the empirical analysis and or testing of formal models. This course surveys a wide range of methodological issues at the intersection of formal models and empirical analysis, ranging from broad epistemological questions (e.g., What is the empirical content of a formal model? What does it mean to "test" a formal model?) to working through advanced statistical techniques. Topics may include experiments versus field data, case studies as evidence or illustration, comparative statics and partial tests of formal models, structural estimation, econometrics of auctions, strategic discrete choice models, ultimatum games, dynamic games, and multiple equilibria.

509. Advanced Topics in Methods II

Prerequisites: PSC 404, 405, and 505.

This course is designed for graduate students intending to pursue political methodology as a major field. It covers advanced statistical methods that are not yet standard fare in political methodology courses. Course content varies year to year; some semesters focus more heavily on nonparametric methods, the bootstrap, computational methods, and estimating structural models. As a research workshop, this course also allows students to pursue areas of individual interest in more depth, and, therefore, course content is determined based on the interests of both the professor and the students. (Rarely)

510. Political Parties and Elections

Why did parties emerge? How have political parties changed? Is politics today more candidate-centered than party-centered? If so, so what? If parties are losing their grip on the loyalties of the voters, why are parties growing stronger and more meaningful as organizations and in Congress? Is democracy workable without political parties? This is a reading course addressing these and related questions. Undergraduates wishing to take this course must discuss their interest with the instructor and secure his or her permission prior to registering. This course may be taken for upper-level writing credit. (Rarely)

511. Public Opinion and Electoral Behavior

This is a reading, discussion, and research seminar that introduces literature on political participation, voting behavior, and related aspects of public opinion. There is enormous literature in this field, and it is growing all of the time. Nonetheless, at the end of this course, students have an excellent foundation in the field. Included are a few classic readings, but most are contemporary works that represent the latest theories and empirical work as well as suggested new directions for study. Where appropriate, the material deals with public opinion more broadly and with institutional factors that influence voting behavior. At times, appropriate comparative studies are brought into class, though
most of the work is on the United States. Students finish the course with a comprehensive understanding of past public opinion and voting behavior research and a good idea of the directions in which that research is now moving. (Rarely)

512. Voting and Elections
This is a reading, discussion, and research seminar that introduces literature on voting, candidates, and elections, both generally and as it relates to legislatures in particular. There is enormous literature in this field, and it is growing all of the time. Nonetheless, at the end of this course, students have an excellent foundation. Included are a few classic readings, but most are contemporary works that represent the latest theories and empirical work as well as suggested new directions for study. Where appropriate, the material deals with public opinion more broadly and with institutional factors that influence elections. Students finish the course with a comprehensive understanding of past research and a good idea of the directions in which that research is now moving. (Every other year)

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 the European Union is included). The course focuses on 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. (Occasionally)

518. Emergence of the Modern Congress
Through intensive reading and discussion, the course analyzes major issues in congressional history and legislative institutions. Students examine the basic institutions of the House and Senate—committees, parties, leaders, and rules. Included are the development of careerism, the seniority system, agenda-setting, electoral concerns, the relationship between Congress and the president, divided government, and efforts at institutional reform. The course is designed to introduce students to the principal approaches used by political scientists to study Congress, with special emphasis on the development of congressional institutions over time. This is an advanced seminar, primarily for graduate students but open also to juniors and seniors with substantial background in political science, economics, and history. (Every 2–3 years)

519. American Legislative Institutions
The United States Congress has always dominated the modern study of legislatures. In recent years, however, legislative scholars have paid increasing attention to the value of comparative studies. American state legislatures, in particular, offer a rich field for examining the impact (and origins) of institutional differences. This course looks side-by-side at the U.S. House, the U.S. Senate, and the 99 state legislative chambers. The course examines the major institutions within a legislative chamber, including the role of committees, leaders, parties, and rules in legislative organization. But taking advantage of this comparative approach, students also gain insight into the effects of term limits, bicameralism, party competition, seniority systems, professionalization, careerism, ideological heterogeneity, money in politics, and links between campaigns and governance. This is an advanced seminar, designed for graduate students but open to qualified undergraduates with permission of the instructors. (Every 2–3 years)

523. American Politics Field Seminar
This seminar introduces classic as well as contemporary research in American politics. Students 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 provides a foundation for developing a comprehensive understanding of the field and the various directions in which it is now moving. (Every other year)

525. Race and Political Representation
The course introduces democratic theory, the civil rights movement, the Voting Rights Act, African-American public opinion and electoral behavior, and the effect of electoral rules and districting decisions on representation. (Every 2–3 years)

530. Urban Change and City Politics
Through intensive reading and discussion, the course examines the politics and history of American cities. The course emphasizes the ways in which ethnicity, race, and class shape battles over housing, neighborhoods, workplaces, schools, and governmental institutions. Students examine the relationship between urban neighborhoods and suburbs, the sources of inner-city poverty and residential segregation, city services, economic constraints, and the nature of political alliances. In exploring these topics, students analyze how institutions—governments, party organizations, reform movements, churches and synagogues, city charters—shape the decisions that urban residents can make.

535. Bureaucratic Politics
Prerequisite: permission of the instructor or at least one course in Techniques of Analysis at the 200 level or above and one course in Positive Theory at the 200 level or above.

This course surveys recent research on the politics of bureaucracy. It begins with a study of why and when elected politicians create bureaucracies and delegate authority to them. Then students study a series of topics regarding the operation and design of existing bureaucracies. Depending on the interest of students, topics include oversight and control of bureaucracies by elected politicians; bureaucratic capacity and performance; the political economy of regulatory bureaucracies; red tape and corruption; judicial control of bureaucracy; institutions and practices for the staffing of bureaucracies (e.g., patronage systems); advisory bureaucracies and bureaucratic expertise in policymaking; and military and intelligence bureaucracies. The course draws heavily, but not exclusively, on formal theories and statistical evidence. (Every 2–3 years)
536. Corporate Political Strategy

This multidisciplinary PhD course studies the role of corporations in the political process. Topics include integrated strategy, political risk, the returns to political activity, and corporate social responsibility. Readings are drawn from the management, economics, finance, and political science literatures. In this course, students develop a deeper understanding of the interplay between business and government, consider the benefits of a multidisciplinary approach for studying this subject, and explore future directions for research. (Every other year)

540. Models in American Politics: Theory and Data

In recent years, there has been an upsurge in American politics research that combines formal modeling and data analysis. In this seminar, students critically examine the strengths and weaknesses of the approach and explore some of the major contributions to this literature. Topics include committee composition, party power, interbranch bargaining, lobbying, and the role of rules.

545. Judicial Politics

How do judges decide cases? Are judges more similar to other political actors than we might think? This course addresses these questions by exploring contemporary political science scholarship on the U.S. courts. The class covers the importance and measurement of judicial ideology, the role of ascriptive and professional characteristics of judges, strategic opinion assignment and writing, and the relationship of higher and lower courts. At the end of the course, students are familiar with all major research areas within the field of judicial politics and are able to undertake their own original research in the field.

550. Comparative Politics Field Seminar

This course provides general conceptual background and an introduction to some major works in the comparative field and subfields. Comparative politics is a field that attempts to develop and test theories that can be used to explain political events and patterns across political systems, especially nation-states. Topics include political culture, development and democratization, political regimes, violence and revolution, elections, social movements, parties, coalitions, institutions, and comparative public policy. The works are discussed and compared both in terms of the major substantive arguments and the methodological approaches taken to enhance the credibility of the arguments. The reading load is heavy and students are expected to write a number of short papers, which are presented in class, as well as a midterm and one longer analytic essay. (Every other year)

551. Western European Politics

This is a graduate-level seminar on the domestic institutions and political processes defining Western Europe since 1945. Several countries, including Britain, France, and Germany, are examined in the context of comparative themes. These topics include political parties, interest groups, and changing patterns of interest articulation and representation; the politics of federalism and regionalism; governmental and electoral types; concepts of race, ethnicity, and citizenship; and the Europeanization of domestic politics. (Every 2–3 years)

553. Ethnic Politics

What motivates the adoption of or identification with one ethnic group over another? How does ethnic identity shape an individual’s political decisions or outcomes such as public goods provision, economic growth, and political violence? This course explores the growing literature on ethnic politics in the comparative politics and international relations sub-fields. Students consider multiple methodological approaches to these questions and explore the dynamics of ethnic identity formation, ethnic-based political behavior, and ethnic cooperation and conflict in a range of empirical contexts. (Every 2–3 years)

555. Democratic Political Processes

This course is a graduate seminar, involving collective discussion of core readings and student presentations on special topics and specific countries. The comparative democratic political processes subfield focuses on the process of choosing political leaders and making political decisions in the context of competitive elections and relative freedom of political action. The course begins by discussing the empirical meaning of contemporary democracies, the nature of democratic transitions, and the effect of social and economic context. Students then take quick looks at differing citizen values, constitutional rules, and the comparative study of citizens’ attitudes and behavior. The second half of the course focuses on groups and, especially, political parties: competition, organization, coalitions, legislative and executive behavior, and connections between citizens and policy makers. Although for graduate students the course fulfills requirements for the democratic political processes subfield in comparative politics, no specific background is assumed and the course is appropriate for any graduate student. (Every 2–3 years)

558. Comparative Parties and Elections

How and why do political parties emerge? What are the causes and consequences of adopting different electoral rules? Under what conditions do voters behave strategically? This course examines the growing literature on parties, electoral systems, and voting in comparative politics. Students consider multiple methodological approaches to these questions and explore the dynamics of voting, elections, and party competition in a range of empirical contexts. (Every 2–3 years)

561. Latin American Politics

This seminar focuses on key questions facing scholars of contemporary Latin American politics: Under what conditions do democratic regimes emerge and endure? Under what conditions are politicians responsive to citizens? Does the choice of political institutions matter? What factors affect institutional instability and weakness? The first part of the seminar considers a variety of approaches to regime transition, including explanations based on class, culture, and individual preferences. The second part of
the course begins with an analysis of the quality of democracy and representation in Latin America. To evaluate the impact of specific institutions on democracy, the course considers the advantages and drawbacks of presidential democracy. Particular emphasis is placed on understanding variation in inter-branch relations over time and across countries. The course concludes with a survey of emerging research on timely topics, including indigenous movements, corruption, and institutional instability. (Every 2–3 years)

564. Comparative Political Economy
This graduate seminar offers a broad survey of research in comparative political economy. More specifically, students study how various political institutions, processes, and events affect economic policy and outcomes as well as the converse, how economic performance and interests influence the development of institutions and political outcomes. The primary goal of this course is to help students identify research opportunities in the literature. Accordingly, emphasis is placed on the generation of research proposals that reflect a sound understanding of the state of the field. Students are evaluated on short assignments, participation, presentations, and a final research proposal. (Every other year)

565. Political Economy of Development
This course surveys selected topics in the extensive literature on political and economic development. The course focuses on differences in formal and informal institutions across countries. Topics include the determinants of economic growth, the modernization hypothesis, distributional conflict, government corruption, and the success and failure of states to deliver public goods, among others.

568. International Organization
This is an advanced course intended for PhD students. The course surveys theories of international organization, the development of formal and informal international institutions, and important recent contributions to research in the field. Course requirements include a research paper and a final exam. (Every other year)

570. Civil Order and Civil Violence
The course covers theoretical and empirical scholarship on how political order is maintained and how it breaks down. Four literatures are covered: canonical theories of social order and change; the origins and nature of the state; revolution; and civil war. Evaluation is based on class participation and multiple short, writing assignments over the course of the semester. Graduate students in political science may count this course toward the international relations or comparative politics subfield. (Every other year)

571. Quantitative Approaches to International Politics
Prerequisites: PSC 505 and 572 (or similar course) required; PSC 506 recommended.
This course examines statistical issues relevant to the study of international politics. Students consider issues such as strategic decision making, geographic interdependence, temporal dynamics, and the operationalization of major concepts, such as power. Of particular interest is the use and limitations of dyadic data and cross-sectional time series data. (Every other year)

572. International Politics Field Seminar
An advanced course intended to prepare PhD students for comprehensive exams in international relations. The course conducts a broad survey of influential works in the field and of current research into the causes of international conflict and cooperation. Extraordinarily well-prepared undergraduates may be admitted. (Every other year)

573. Territory and Group Conflict
This graduate seminar examines a long-neglected topic: the role of territory in group politics. The goal is to build a basic understanding of why, when, how, and which territory becomes contested. Students read from a broad range of disciplines. Students are expected to write two short papers for two different sessions, which are not to exceed 1,500 words. Each paper should provide an independent commentary of the student's own on some aspect of that week's readings. These papers form the background for discussion in class. In addition, students are required to write a 20–25 page research paper that focuses in depth on one of the discussed emerging research agendas. As in other graduate seminars, the course is conducted almost exclusively through discussion. Hence it is crucial that students do the reading in advance and set aside time to reflect on the readings and prepare comments and questions. (Every 2–3 years)

574. International Political Economy
This seminar covers advanced-level key issues in the study of international political economy in detail. Students should be prepared for very considerable responsibilities of critical reading and preparation for informed participation in discussion. Topics examined include the following: paradigmatic debates, hegemonic stability and international institutions, linkage strategies and economic sanctions, classes and coalitions, domestic institutions, bilateralism and multilateralism, credibility and macroeconomic coordination, international debt, international environmental policy, and the collapse of the Soviet bloc. (Every other year)
575. Political Economy I
The course covers the primary results in preference aggregation and applies them to models of elections and policymaking. The focus of the course is especially on dynamic models of politics. The course begins by studying Arrow's theorem and majority voting, reviewing the workhorse models of elections in the political economy literature, and using these models to study taxation and inequality, interest groups, and lobbying, etc. In the second part of the course, students extend the analysis to repeated elections and electoral accountability. Also covered is the literature on political agency with moral hazard and adverse selection. The course consists of a mix of lectures, discussion, and student presentation of assigned readings.

576. Modeling International Conflict
This course is intended for advanced graduate students interested in formal and quantitative analysis of international conflict. It pulls together various techniques for such analysis and applies those techniques in a systematic manner to issues in international conflict. Particular attention is paid to formalizing theories of conflict and then testing those theories with statistical models derived from the formalizations. The goal is for students to (1) derive or prove results presented by the various authors, (2) identify contributions made by the authors, and (3) identify ways to improve upon the research. Because the course involves the application of game-theoretic and statistical techniques, students must have completed graduate courses in (1) mathematical statistics, (2) introductory econometrics, and (3) introductory game theory. (Every 2–3 years)

577. Theories of Conflict
Prerequisite: PSC 584 (or concurrently) or have an equivalent knowledge of complete and incomplete information game theory.
This course examines the literature on conflict that has developed in the last decade. Students examine recent formal literature as well as the latest substantive (nonformal) literature on conflict. The course helps graduate students identify the broad direction of international conflict studies and also permits graduate students to pursue topics or ideas of their own interest. To that end, two classes for “model building sessions,” where students can explore approaches to formalize some of the ideas in the substantive literature or explore extensions of the current formal literature, are set aside. (Every other year)

578. International Conflict: Theory and History
This is a course intended to provide graduate students with a survey of the history of international conflict, focusing on European and U.S. diplomatic history from 1763 to 1989. (Every other year)

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. (Every 2–3 years)

580. Political Economy of Development
This course reviews recent advances in nondemocratic politics and the political economy of developing countries. Students tackle such issues as the economic foundations of democratic transitions and the economic impact of power struggles in dictatorships. The course combines the use of formal models with case studies and econometrics. (Every other year)

581. Foundations of Political Theory
This seminar addresses different topics in different years. This year (Fall 2014) the topic is Democratic Theory. Students read a range of classic and contemporary works on a variety of topics in this domain. The primary focus is on the role of democratic decision-making mechanisms in the design and redesign of political-economic institutions.

582. Political Economy II
Social networks pervade political and economic life. They shape how we acquire political knowledge, how we discover job opportunities, and how we shape and maintain norms. The multitude of ways that networks affect the world make it critical to understand how network structures impact behavior, which network structures are likely to emerge, and why we organize ourselves as we do. Drawing on a wide variety of fields, this course reviews the literature, both theoretical and empirical, on social, economic, and political networks. Topics include basic network structures, network formation, games on networks, learning, diffusion, and methods for network analysis.

583. Culture and Politics
Social scientists often claim that there is an intimate relationship between culture and politics. They, unfortunately, have made scant progress in elaborating the theoretical resources needed to analyze that relationship. This has led several observers to conclude that the “systemic study of politics and culture is moribund.” The aim in this seminar is to remedy this sorry state. More specifically, this course tries to identify the theoretical resources that might allow more cogent analyses of the relation between culture and politics. In the process, students range across disciplines, with readings drawn from anthropology, economics, history, philosophy, political science, and sociology. The course is run as a seminar, which means that all students must participate actively. (Rarely)

584. Game Theory
Prerequisites: PSC 407 and 408 or an equivalent background in complete information 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. 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 stability of international systems, the conduct of war, legislative policymaking, regime change, and the impact of political variables on economic growth and industry dynamics. This course provides theoretical and computational tools for the study of such applications. Covered are the basics of dynamic programming and general dynamic games and the main results on Markov chains. The main focus is the study of stochastic games with an emphasis on numerical analysis of simple (i.e., finite) models illustrated in a number of applications. The goal of the course is to equip graduate students with analytical and numerical tools that can be used in their future research on applied topics. 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. (Every other year)

**586. Voting and Elections**
The course focuses on several foundational topics in theoretical political economy. Students are first exposed to the analysis of fundamental concepts used throughout the course: binary relations, preferences, and choice. They then study social choice theory, where they view collective decisions as arising from a social preference relations determined in some arbitrary way by the preferences of individuals. Students learn to prove Arrow's impossibility theorem and others, which inform them of inherent limitations on the rationality of collective decisions. The course then changes perspective—viewing collective decision as outcomes of a game played by individual decision makers. Students also consider game-theoretic models of static elections, sequential voting, bargaining, and repeated elections, with a special focus on connections to social choice. (Every 2–3 years)

**588. Bargaining Theory and Applications**
This seminar focuses on the theory of non-cooperative bargaining and its applications in the study of political institutions. The maintained assumption is that agents are optimizers of some sophistication and behave in order to have their preferences prevail, possibly at the cost of efficiency. The theory of multiagent bargaining is covered in depth. Areas of application include parliamentary government formation; endogenous legislative organization (rules of procedure, seniority, committees); debate and information; lobbying; political parties; courts; bureaucracy; formation and breakup of nation-state; federalism; etc. Emphasis on particular topics may vary with the configuration of class interests. Research directions are discussed.

**589. Social Choice, Bargaining, and Elections**
The course covers the primary results in preference aggregation and applies them to models of elections and policymaking. The focus of the course is especially on dynamic models of politics. Students begin by studying Arrow’s theorem and majority voting, reviewing the workhorse models of elections in the political economy literature, and using these models to study taxation and inequality, interest groups, and lobbying, etc. The second part of the course extends the analysis to repeated elections and electoral accountability and covers the literature on political agency with moral hazard and adverse selection. The course consists of a mix of lectures, discussion, and student presentation of assigned readings.
Center for Visual Science

Professors Aslin, Bavelier, DeAngelis, Duffy, Feldon, Fienup, Huxlin, Jacobs, Knox, Lennie, MacRae, Paige, Pasternak, Pouget, Rolland, Schieber, Williams (Director)
Associate Professors Chung, Freedman, Gan, Romanski, Tadin, Yoon, Zavislan
Assistant Professors Hayden, Hindman, Hunter, Libby, Mahon, Majewska
Adjunct Associate Professor DiLoreto

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, neurobiology and anatomy, 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.

VISION COURSES

448. Vision and the Eye
(Same as BCS 526 and OPT 448)

The human visual system is the most sophisticated imaging system known. This course reveals the intricate optical and neural machinery inside the eye that allows us to see. It describes 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. The course compares the human eye with the acute eyes of predatory birds and the compound eyes of insects. The course also describes 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 sciences, but is recommended for anyone with a curiosity about vision or an interest in biomedical applications of optics. The course also serves as an introduction to the study of vision for graduate students.

504. Sensory Systems
(Same as BCS 504)

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 and Motor Systems
(Same as BCS 505)

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
(Same as BCS 524)

This is a reading seminar that looks at modern research on statistical learning in a number of areas in perception, action, and cognition. The course focuses 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).
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 Creceh, 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.
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 centuries 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 1830s, 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 interconnected artistic concerns and subjects of artists such as Manet, Monet, Renoir, Pissaro, 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 audience. 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 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 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 Herederos 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 connections between social change and art. Texts and discussions are in English.

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 homophile 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 Besson, Andre Techine, Cyril Collard (Savage Nights), Mathieu Kassovitz, Claire Denis, Francois, 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, Własowa Szymborska, Miroslav 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 temporali- ties; 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 supple 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 gives 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 decade 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 and 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.

**Literary Translation Program**

Professors 1DiPiero, 2Gustafson, 3Jörgensen, 1London, 1Michael, 5Schaefer, 1Scott
Associate Professors 1Grotz, 1Kegl

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 graduate certificate and a Master of Arts degree. The Master of Arts in literary translation is for those preparing for careers as literary translators.

**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). (A graduate certificate in literary translation is also available. Students follow the same curriculum as master’s students but do not complete the thesis.)

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.

* Primary appointment in another department
1 Department of English
2 Department of Modern Languages and Cultures
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

Element 1 (required)
Studies in Translation
This course introduces students to the theoretical backgrounds, practical challenges, and creative activity of literary translation. It surveys appropriate theories of language and communication, including semiotics, poststructuralism, pragmatics, discourse analysis, and cognitive linguistics. This course considers varied and conflicting descriptions by translators of what it is they believe they are doing and what they hope to accomplish by doing it. Further, students 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 developing a sense of the kinds of texts translations actually are. Finally, students undertake, in consultation with the instructor or with another qualified faculty member, exercises in translation of their own. By the end of this class, each student possesses a working knowledge of both the critical backgrounds and the artistic potentials of translation.

Element 2 (required)
Independent Project and 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 becomes the centerpiece of their translation portfolio. The translation portfolio also includes other translations done independently as well as those done for other components of the program.

Element 3 (required)
Fiction, Poetry, or Theater: Writing and Translation Workshop
To capture the subtleties of the original literary work and communicate its unique aspects in English, a translator must be a skilled and versatile writer in control of style and structure. Element 3 in the Literary Translation Program is designed to provide students with opportunities to share and critique works-in-progress with other literary translation students and creative writers.

II. ELECTIVE COMPONENTS

Element 4
Studies in International Literature
Focusing on literary works from a number of different national cultures, these courses, which are offered through several departments and change from semester to semester, explore the interactions of literatures from different national contexts. By definition, international literature treats more than one culture and involves the study of thematic and stylistic differences, as well as connections between and among cultures. Special attention is paid to the critical issues of intercultural influence and transmission. Courses in international literature analyze how one culture understands another through literary representation. To that end, these courses explore topics related to the movements of people and cultures within the context of globalization, and they do so by focusing specifically on the literary text. Issues for discussion may include the way different national literatures influence each other, how ideas of the literary transform and are transformed by their travel into different cultures, how literature circulates in an international context, and how international culture makes and breaks literary reputations. Students are invited to investigate why the category of international literature exists in the first place, its ramifications for individual cultures and for the world, and the problems and possibilities such a category poses.

Element 5
Advanced Literary Studies
To gain more in-depth knowledge of a specific area of literature, students may choose to focus their studies with graduate literature courses. In consultation with an advisor, students may choose appropriate courses at the 400 level or higher from the Departments of Modern Languages and Cultures, English, and/or Religion and Classics.

For current representative courses, please see listings in the Departments of English, Modern Languages and Cultures, and Religion and Classics.

Element 6
Publishing Practices and Internship
Literary translation students interested in pursuing a career in translating or publishing are encouraged to participate in one of the following internship programs:

Editorial Internships with Rochester’s Open Letter press—Editorial interns have the opportunity to research literature from
around the world and to work with international publishers and foreign agencies to obtain information on untranslated authors. Interns are responsible for reading and reporting on untranslated texts, providing sample translations of books under consideration, and writing for the LTS/Open Letter press website.

**International Publishing Internships**—A limited number of international internships may also be available to literary translation students at publishing houses in France, Germany, Spain, Mexico, Italy, and Japan.

**Domestic Publishing Internships**—Literary translation students may be able to intern with U.S. publishing houses or literary magazines involved in international literature, such as New Directions, Archipelago Books, and Graywolf.

### III. THESIS COMPONENT

#### Element 7

**Final Translation Project**

Under the direction of an advisor, students complete a book-length translation of a complete work or of a significant selection of a complete work large enough to be presented to a press for publication. The translation is accompanied by an analysis addressing the significant theoretical and practical problems encountered in the work’s translation. The translation also contains a short critical introduction, which addresses issues such as the selection of author; the selection of texts in the case of a thesis that is not a translation of a stand-alone work; the balance of cultural and linguistic fidelity with literary readability; how the translation itself is a new way of understanding the source text; translation as literary theory; and potential appeal and market of the translation.

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**Susan B. Anthony Institute for Gender and Women’s Studies**

**Professor Honey Meconi (Director)**

**Susan B. Anthony Professor of Gender and Women’s Studies**

The Susan B. Anthony Institute for Gender and Women’s Studies offers a formal Graduate Certificate in Gender and Women’s Studies for students who are enrolled in a graduate degree (master’s or PhD) 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/wst](http://www.rochester.edu/college/wst)).

Gender and women’s studies focuses on the experiences of diverse groups of women and the changing cultural, economic, political, and psychological relations between women and men. Because women’s studies asks questions about women and about gender that no single academic department is able to answer, the program encourages an interdisciplinary approach to research and learning. The Susan B. Anthony Institute includes faculty associates in the humanities, social sciences, and sciences from all six colleges in the University.

The Graduate Certificate in Gender and Women’s Studies provides analyses of contemporary theoretical frameworks and methodologies; a historical perspective on gender and women’s studies within and across disciplines; a focus on issues of gender, race, class, and ethnicity; and connections between academic and nonacademic practices. The certificate becomes part of the student’s record and serves to document training in gender and women’s studies. 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 women’s studies.
W. Allen Wallis Institute of Political Economy

Professors Duggan, Rothenberg
Associate Professors Fey, Stone, Kalandrakis, Primo
Assistant Professors Caetano, Pancs

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 making. Specialized topics may include candidate motivations, strategic voting, lobbying, and taxation, among others. The methodological focus of the course may range from formal modeling to computational analysis to empirical methods. Content of the course may vary with the instructor.

575. Political Economy I
(Same as PSC 575, ECO 575)

The course takes up foundational topics in theoretical political economy. It begins with the analysis of fundamental concepts of preference and choice used throughout the course. The course then covers the main results in social choice theory, where collective decisions are viewed as the product of an abstract process of preference aggregation. Results covered include Arrow’s impossibility theorem and Black’s median voter theorem. The course then moves to the game-theoretic analysis of elections, voting, and legislative bargaining, with a special focus on connections to social choice theory. Content of the course may vary with the instructor.

582. Political Economy II
(Same as PSC 586, ECO 582)
Prerequisite: PEC 575 is recommended (but not required).

The course builds on the theoretical foundations of Political Economy I and delves into the topics of elections, voting, and legislative policy making. Specialized topics may include candidate motivations, strategic voting, lobbying, and taxation, among others. The methodological focus of the course may range from formal modeling to computational analysis to empirical methods. Content of the course may vary with the instructor.
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Andrey V. Okishev, PhD (Institute of Fine Mechanics and Optics)
Scientist in the Laboratory for Laser Energetics

Semyon Papernov, PhD (Latvian U. Riga)
Scientist in the Laboratory for Laser Energetics

Sean P. Regan, PhD (Johns Hopkins)
Scientist in the Laboratory for Laser Energetics

Alexander Ryskin, PhD (USSR Academy of Sciences)
Scientist in the Laboratory for Laser Energetics

Ansgar Schmid, PhD (Tech. U. Vienna)
Scientist in the Laboratory for Laser Energetics

Robert Short, PhD (Wisconsin)
Senior Scientist in the Laboratory for Laser Energetics

Stanley Skupsky, PhD (Chicago)
Senior Scientist and Director of Theory in the Laboratory for Laser Energetics

John M. Soures, PhD (Rochester)
Senior Scientist in the Laboratory for Laser Energetics

Christian Stoeckl, PhD (Technische Hochschule Darmstadt)
Scientist in the Laboratory for Laser Energetics

Charles Verdon, PhD (Arizona)
Senior Scientist in the Laboratory for Laser Energetics

Anatoliy Vorobyev, PhD (Tomsk State University)
Senior Scientist in the Institute of Optics

Barukh Yaakobi, PhD (Hebrew)
Senior Scientist in the Laboratory for Laser Energetics

* Part-time
† Primary appointment in the School of Medicine and Dentistry
Biomedical Engineering


Adjunct Associate Professors Borkholder, Davis

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 from the ground up 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 newly launched 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, 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, P.O. Box 270168, Rochester, NY 14627-0168.

404. Computational Methods Applied to Biological Systems
Computational methods to solve analytically intractable mathematical problems in biological research. Using MATLAB as a programming language; numerical methods for linear algebra, ODE, and PDE; case studies such as biodynamics of human locomotion, ion channel kinetics, ionic diffusion in cells, and finite element analysis of cells/tissues.

411. Applied Cellular and Molecular Biology
Molecular biology, biochemistry, and genetics that are required to understand the biomedical and broader biological issues that affect our lives.

412. Viscoelasticity in Biological 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 develops 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 is introduced. An emphasis is placed on applications to cartilage, tendon, ligament, muscle, blood vessels, and other biological tissues. Advanced topics, including thermoviscoelasticity, nonlinear viscoelasticity, composite viscoelasticity, and physical mechanisms of viscoelasticity, are surveyed.

418. Introduction to Neuroengineering

420. Biomedical Nanotechnology
This course is designed to provide students with detailed knowledge of principles and applications of nanotechnology in the biomedical field. Topics include synthesis and assembly of nanoscale structures, lithography, nanobiomaterials and nanobiomechanics along with the applications of nanotechnology in biomedical engineering.

428. Physiological Control Systems
The course focuses on the application of control theory to physiological systems. Lectures present modern control theory in the context of physiological systems that utilized feedback mechanisms. Lectures begin with an overview of linear systems analysis including Laplace transforms and transfer functions. The response dynamics of open- and closed-loop systems such as the regulation of cardiac output and level of glucose are discussed. Other topics include stability analysis and identification of physiological control systems.

* Primary appointment in another department

This course offers students exposure to the intellectual property (IP) and regulatory pathways for new medical innovations. Students learn the terminology, processes, and challenges involved in FDA regulations and the protection of intellectual property for medical innovations. An emphasis is placed on the ways knowledge of prior art and regulatory barriers can optimize concept selection and early-phase project planning to best identify projects suitable for commercialization. Instruction includes 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 alternate in order to allow students to understand the difficulty presented by balancing these two challenges in the innovation process. Assignments may be tailored to individual students' research, design, or work concentration areas.


This interactive course focuses on intellectual property (IP) and FDA regulatory pathways for implementation of commercialization of new medical innovations. Emphasis is placed on the ways that knowledge of IP protection and regulatory barriers can optimize design, testing, and commercialization strategies. Building on the basics learned in BME 431, students learn about the processes (and barriers) to bringing a product such as a novel medical device to clinical trials. Instruction includes 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 alternate in order to allow students to understand 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 and may be reviewed by the course instructors as well as consultants directly familiar with the process.

434. Microbiomechanics

This course covers the application of mechanical principles to biotechnology and to understanding life at its smallest scales. Topics 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.

445. Biomaterials Science and Engineering

This course provides a background in biomaterials: 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.

448. Controlled Release Systems

This course covers the principles, strategies, and materials used in controlled drug delivery systems.

451. Biomedical Ultrasound

Prerequisite: permission of instructor.

The physical basis for the use of high-frequency sound in medicine (diagnosis, therapy, and surgery) and biology. Acoustic properties of tissues, sound propagation in tissues, including linear processes as well as finite amplitude sound propagation, and the development of shock waves, interactions of ultrasound with gas bodies, leading to the phenomenon of acoustic cavitation, thermal and nonthermal biological effects of ultrasound, ultrasonography, dosimetry, radiation diathermy, thermal surgery, lithotripsy.

452. Medical Imaging—Theory and 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.

453. Advanced Biomedical Ultrasound

Prerequisites: BME 451 or permission of 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.

454. Principles of Magnetic Resonance Imaging

This course introduces the principles of MRI and its applications to graduate and undergraduate students. The acquisition and reconstruction of MR images is covered in detail.

455. Translational Biomedical Optics

This course focuses on the macroscopic biomedical optics techniques (e.g., diffuse optical spectroscopy and tomography, photoacoustic tomography) with high potentials for clinical translation. Students learn the aspects of instrumentation design, analytic and numerical approaches for optical data analysis, and validation of new technologies in the clinical setting.

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 and Tissue Engineering  
Prerequisites: BME 260, CHE 225, CHE 243, CHE 244 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 five 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. Instructors 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 identify a technological need and present orally and in writing a proposal to meet that need.

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.

467. Models and Simulations of Biomedical Systems  
Prerequisites: BME 221 and 230 or permission of instructor.

This course introduces analytical modeling and computational simulations of systems. Examples include cardiovascular, respiratory, muscle, neural, and population models.

470. Biomedical Microscopy  
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.

474. Biomedical Sensors, Circuits, and Interfacing  
Course covers circuits and sensors use to measure physiological systems at an advanced level. Both signal conditioning and sensor characteristics are addressed. Topics include measurement of strain, pressure, flow, temperature, biopotentials, and physical circuit construction. The corequisite laboratory focuses on the practical implementation of electronic devices for biomedical measurements.

483. Biosolid Mechanics  
Application of engineering mechanics to biological tissues including muscle, soft tissue, cell membranes, and bone. Realistic modeling of biological structures, including the heart, blood vessels, and the skeleton. Experimental and computational methods and material models.

485. Cell and Membrane Mechanics  
Prerequisites: background in solid mechanics, some cell biology is desirable; permission of instructor is required.

The primary focus of this course is on the fundamental science underlying the mechanical behavior of cell membranes, with some additional attention given to the mechanical behavior of leukocytes. The approach is to explore mathematical descriptions of the physical properties biomembrane structures. Basic aspects of the structure and composition of cell membranes are reviewed as a basis for the mathematical treatments.

486. Finite Elements  
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.

502. Analytic Foundations in Biomedical Engineering  
The goal of this course is to introduce students to a select range of key concepts and methods from engineering and applied mathematics that are common across most subdisciplines of BME and to illustrate by example how these concepts and methods can be applied directly in the study of biological systems and/or for the solving of biological problems. We expect that students completing the course will have acquired basic practical skills to develop novel analytic approaches to biological problems and will be well prepared for subsequent coursework in their chosen discipline.

513. Introduction to fMRI: Imaging, Computational Analysis, and Neural Representations  
Prerequisite: graduate-level math course.

The core focus of the course is on how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing.

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.
589. Writing Proposals in BME
This course covers the essential aspects of organization and content for writing formal scientific proposals. Open to second-year PhD candidates.

593. Lab Rotations in BME
Students rotate in at least three different labs during the first year of graduate study to learn of the diversity of research opportunities for PhD research.

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, radiation oncology, 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 professionals from a diverse selection of departments at the University of Rochester, as well as colleagues from Rochester General Hospital and Rochester Institute of Technology. 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 disciplines complements the rich environment for research in biomedical ultrasound. The Center sponsors seminars, international workshops, 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 and workshops, and requesting an assignment as a research assistant as projects become available.

Visit the RCBU website at www.urmc.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 electro-optics, 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 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

Professors Chen, Chimowitz, Jorné, Tang, Yates (Chair), Wu
Associate Professors Anthamatten, Foster, Kelley
Assistant Professors Mukairo, Shestopalov, Tenhaeff, White
Adjunct Assistant Zacharakis
Joint Appointments: Professors Jacobs, Harding, Rothberg, Shapiro; Assistant Professor Benoit
Professors Emeriti Feinberg, Ferron, Saltsburg

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 12 credit hours earned through research courses. The formal courses must include three “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 three “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 fluid dynamics/transport phenomena (e.g., CHE 441)
- Thermodynamics and statistical mechanics (e.g., CHE 455)
- Applied Mathematics (e.g., CHE 400)

For those students entering without a chemical engineering background, the core course requirement may be obtained by taking two undergraduate courses* in the following areas offered by the department: Thermodynamics (CHE 225), Heat and Mass Transfer (CHE 244), Fluid Dynamics (CHE 243), Separation Processes (CHE 250), and Reactor Design (CHE 231), plus one graduate-level course from the core areas listed above.

All courses carry four credit hours unless otherwise noted.

**Chemical Engineering Fundamentals**

**400. Applied Boundary Value Problems**

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 is used extensively. Prior knowledge of Mathematica is helpful but not essential. In the last two weeks of the course, there is a project on an assigned topic. The course includes applications in heat conduction, electrostatics, fluid flow, and acoustics.

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* 200- and 300-level courses carry three rather than four graduate credits.
441. Advanced Transport Phenomena
This course acquaints 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 is to develop physical understanding of principles discussed and emphasis on chemical engineering applications. In addition to the text, the student is exposed to classic and current literature in the field. (Fall)

454. Interfacial Engineering
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, micelles, microemulsions, and colloidal dispersions. Techniques for formation and characterization of interfaces and colloids are reviewed. (Spring)

455. Thermodynamics and Statistical Mechanics
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 noninteracting quantum systems are expressed in terms of partition functions, for gases of simple and complex particles. Nonequilibrium statistical behavior of multipartite systems leads to diffusion and other transport phenomena. (Fall)

460. Solar Cells
This course introduces 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 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 are a part of the coursework.

464. Biofuels: Biological Approach
An overview of biological science, technologies, and processes relating to biomass as an alternative energy source.

465. Thermochemical Biomass Conversion
Conversion of biomass to liquid fuels and chemical feedstocks traditionally derived from petroleum. Production of jet fuel, gasoline, and diesel fuel via gasification, liquefaction, pyrolysis, aqueous phase reforming, and transesterification of a variety of biomass. Generation of chemical platforms in support of food, drug, pharmaceutical, and polymer industries. Green chemistry and engineering aimed to improve sustainability of chemical conversions of a plethora of key intermediates originating from biomass. Use of environmentally benign solvents—such as ionic liquids, water, and supercritical carbon dioxide—in place of organic solvents. Catalytic chemical reactions with ball milling, microwave irradiation, and sonochemistry using minimum catalysts and solvents while maximizing reaction rates and yields for ease of product isolation and purification. Microreactor technology to maximize heat and mass transfer rates, reaction yields and product selectivities, and to facilitate process control, optimization, and scale-up.

485. Advanced Thermodynamics
Thermodynamic stability theory and its relationship to the first and second laws of thermodynamics. The use of the Legendre function formalism to derive all relevant thermodynamic potentials and the Gibbs-Duhem equation. Introduction to statistical mechanics and its application to molecular modeling of thermodynamic properties for pure components and mixtures. Mean-field theories, equations of state and statistical mechanical perturbation theory with applications to phase and chemical equilibrium calculations. (Spring)

ADVANCED MATERIALS

413. Engineering of Soft Matter
This course provides an overview of several contemporary research topics pertaining to structured organic materials. Lectures focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials. (Spring)

421. Thin-Film Processing
This course covers the fundamentals and techniques involved in making thin films. Gas phase processes such as chemical and physical vapor deposition are emphasized. The advantages and limitations of each technique, and the associated material properties, are discussed. Scientific and engineering fundamentals that are required to better understand these processing techniques are reviewed within the appropriate context. These include gas kinetic theory, vacuum principles, heat and mass transport, and methods for characterizing materials. Contemporary computational modeling techniques are introduced. (Alternate falls)

430. Organic Electronics
Basic optical and electronic processes of organic molecules and polymers. Charge transport and luminescent properties of organic solids. Metal/organic contacts and charge injection. Applications in thin-film organic electronic devices including organic light-emitting diodes, solar cells, photoconductors, and transistors. (Spring)

447. Optics and Liquid Crystals for Chemical Engineering
This course introduces the materials, terminology, effects, and devices used in the field of liquid crystal optics. Basic structures
in nematic and cholesteric liquid crystals are discussed and related to optical phenomena like transmittance, absorptions, scattering, birefringence, and selective reflection (the effect seen in scarab beetles and used to protect the Omega laser in LLE from blowing itself up). Two keys for device applications are LC chemical composition and molecular alignment, and these are covered in order to understand the manufacture and operation of polarizers. The basic electro-optics for active devices like EO switches and LC displays are also covered. Other applications explored include mood rings, polarizing pigments for document security, smart windows, and car paint. Chemical engineering graduate students are given enough introductory optics to understand the concepts and applications described in the course. (Alternate springs)

448. Controlled Releases Systems
This course covers the principles, strategies, and materials used in controlled drug delivery systems.

458. Electrochemical Engineering and Fuel Cells
Credit—two hours
The course concentrates 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 students for the challenges of energy conversion and storage and the environment in the twenty-first century. (Fall)

482. Processing Microelectronic Device
Credit—two hours
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)

486. Polymer Science and Engineering
This course features the science and technology of synthetic macromolecules. Topics include polymerization reactions, structure and properties of semicrystalline and amorphous polymers, characterization of structure and properties, structure property relationships in polymers, and application of polymeric materials. (Fall)

487. Polymer Rheology and Processing
The unique transport and equilibrium properties of organic polymers are studied and applied, with basic chemical engineering principles to the analysis of polymer processing. Topics include fluid flow and heat transfer in polymer systems, rheological equations of polymer systems, rheological equations of state, and the study of fabricating operations, such as calendaring, extrusion, and injection molding. (Alternate springs)

BIOTECHNOLOGY

462. Cell and 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 five areas of the field. In a term project, graduate students must identify a technological need and present orally and in writing a proposal to meet the need. (Spring)

469. Biotechnology and 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)

492. Biointerfaces
The course focuses 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 aims 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 focuses on mechanisms of interactions between biomolecules and surfaces. The second part focuses on the characterization of physical, chemical, and morphological properties of biointerfaces.

ADDITIONAL COURSES

Chemical engineering graduate students are encouraged to take courses outside the department as part of their effort to build a solid foundation for thesis research and to prepare themselves for a dynamic professional career. Some examples are as follows:

BME 431. Pathways to Medical Innovations—Part I
BME 432. Pathways to Medical Innovations—Part II
BME 445. Biomaterials Science and Engineering
CHM 425. Physical Methods in Inorganic Chemistry
CHM 435. Organic Reactions
CHM 451. Quantum Chemistry I
ME 451. Crystallography and X-ray Diffraction
Computer Science

Professors Allen, Brown, Ding, Dwarkadas, Hemaspaandra, Kautz (Chair), Luo, Schubert, Scott
Associate Professors Nelson, Seiferas, Shen
Assistant Professors Gildea, Guo, Hogue, Stefankovic, Venkitesubramaniam
Joint Appointments: Professors Jacobs, Knill, Heinzelman, Huang; Assistant Professors Ipek, Jaeger
Adjunct Instructors Koomen, Kostan, Martin, Raqueno
Undergraduate Program Director Pawlicki
Scientists Ferguson, Swift

The Department of Computer Science offers a program of study leading to the degrees of Doctor of Philosophy and Master of Science. 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 the comprehensive exams at the end of the first year. The master’s degree is offered to those passing with an appropriate level of performance. Admission to PhD candidacy requires a higher performance level. By the end of the third year, each candidate must pass a qualifying examination in the area of thesis research.

Students may also pursue a terminal/professional MS degree (Plan B) on a part-time basis. A “professional master’s” is typically an MS degree pursued on a part-time basis (generally within five years) by a student employed in local industry. A 4+1 program is offered to University of Rochester undergraduates. Financial support is not available for the MS programs.

MS students must pass a comprehensive examination (or essay), typically in the last semester before graduation.

The only required course for PhD students is CSC 400. Credit for courses at the 200 or 300 level is three hours, and credit for research internship courses is one hour. All other courses carry four credit hours except as noted. 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 computer science graduate students.

412. Human-Computer Interaction

Explores the design, implementation, and evaluation of user interfaces.

444. Logical Foundations of Artificial Intelligence

The logical foundations of AI including first-order logic, search, knowledge representation, planning, and probability and decision theory.

446. Mathematical Foundations of Artificial Intelligence

The mathematical foundations of robotics and vision applications in AI.

447. Natural Language Processing

Constructing computer programs that understand natural language. Topics include parsing, semantic analysis, and knowledge representation. (Alternating years with 448.)

448. Statistical Speech and 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. (Alternating years with 447.)

449. Machine Vision

Fundamentals of computer vision, including image formation, elements of human vision, low-level image processing, and pattern recognition techniques.

453. Dynamic Languages and Software Development

Concepts, principles, and practices of dynamic programming languages and modern software design. Advanced techniques in procedural, functional, and object-oriented programming; composition of functions, objects, and modules; design patterns; software process and agile methods; tools for collaborative software development; and select topics in mobile and online software development.

455. Software Analysis and Improvement

The automation of programming itself—how much a program can understand and improve other programs. Combines fundamental principles and (hands-on) practical applications.

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.
457. Computer Networks

458. Parallel and Distributed Systems
Principles of parallel and distributed systems, and the associated implementation and performance issues. Topics 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.

460. Topics in Natural Language Dialog Systems
This course examines recent research in computational linguistics and artificial intelligence on natural dialog systems. Students take turns leading the discussion of current research papers. Graduates taking the course may have additional readings or assignments.

481. Cryptography
The modern study of cryptography investigates techniques for facilitating interactions between distrustful entities. With the advent of large-scale, networked systems such as the Internet, such techniques have become indispensable—enabling, for instance, electronic voting, privacy-preserving auctions, internet banking, satellite radio/television, and more.

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.

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, one-way functions, and cryptography; reductions relating the complexity of problems; complexity classes, and hierarchies.

487. Randomized, Parallel, and Other Advanced Modes of Computation
Advanced modes of computation such as probabilistic computation, counting-based computation, semi-feasible computation, nondeterminism, computation trees, and parallel access.

490. Supervised Teaching
Credit—two hours
Teaching assistantship to fulfill 3-2 master’s program requirement.

491. Advanced Readings in Computer Science
Credit to be arranged
Reading course at the master’s level.

494. Advanced Research Internship in Computer Science
Prerequisite: consent of the department.
Credit—one hour
Master’s-level research internship with sponsoring employers, usually taken during the summer term and lasting three–four months.

495. Advanced Research in Computer Science
Credit to be arranged
Individual research at the master’s level.

509. Topics in Programming Systems
Intensive study of a currently active research topic.

512. Computational Methods in Cognitive Science
Credit—three hours
Mathematical/computational models of visual perception, decision making, learning, and movement control. The objective is to develop technical knowledge and skills needed to formulate, evaluate, and understand such models.

529. Topics in Programming Languages
Intensive study of a currently active research topic.

549. Topics in Artificial Intelligence
Intensive study of a currently active research topic.

559. Topics in Cognitive Science
Intensive study of a currently active research topic.

571–577. Seminars
Credit—one to four hours
Discussions of current literature and research. Seminars can be arranged to suit interests and demands.

571. Seminar in Cognitive Science

572. Seminar in Programming Languages

573. Seminar in Programming Systems
574. Seminar in Theory of Computation
575. Seminar in Numerical Analysis
576. Seminar in Applications of Computer Science
577. Seminar in Artificial Intelligence
578. Seminar in Theory of Computation
579. Seminar in Numerical Analysis
580. Seminar in Applications of Computer Science
581. Seminar in Artificial Intelligence
582. Topics in Theory of Computation
Intensive study of a currently active research topic.
583. PhD Readings in Computer Science
Reading course at the PhD level.
Credit to be arranged
584. PhD Research Internship in Computer Science
Prerequisite: permission of the department.
Credit—one hour
PhD-level research internship with sponsoring employers,
usually taken during the summer term and lasting three–four
quarters.
585. PhD Research in Computer Science
Individual research at the PhD level.
Credit to be arranged

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**Electrical and Computer Engineering**

Professors Bocko (Chair), Donaldson, Friedman, Heinzelman,
Hsiang, Parker, Sobolewski, Waag
Associate Professors Ampadu, Dery, Doyley, Huang, Mortley,
Sharma, Wu
Assistant Professors Duan, Ignjatovic, Ipek, Lin
Assistant Professors (Research) Hesford, Soyata
Joint Appointments: Professors Dalecki, Dwarkadas, Fienup,
Headlam, Ning; Associate Professors Couderc, Wisemueller;
Assistant Professors DeLouise, McAleavey,
Adjunct and Visiting Faculty Appointments: Astheimer, Blackstock, Dereffinko
Scientist Astheimer
Professors Emeriti Carstensen, Jones

The Department of Electrical and Computer Engineering offers
g 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, and bioinformatics. The faculty serve
as directors or key researchers in leading national centers such
as the Center for Biomedical Ultrasound, the Center for Future
Health, the Center for Emerging and Innovative Sciences, 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.

Selected examples of current research in several of these ar-
areas include digital image and image sequence processing, pattern
recognition, medical imaging; fast relaxation processes in semi-
conductors and in superconductors by use of femtosecond laser
pulse; nanoscale silicon for optoelectronics and biosensing; ad-
vanced ULSI and VLSI synchronization and design; analysis and
design of computer-based design tools for enhancing productiv-
ity 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 electrical systems; microfluidics; audio and
music signal processing.

Applicants for graduate study are expected to have per-
formed 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.

The programs of graduate study are intended to serve the
needs of students who terminate studies at the MS level as well
as the needs of students who plan to pursue research at the PhD

level. Advanced graduate students who are seeking to prepare for careers as professors and qualify for the rank of instructor may be assigned regular classroom duties. Research is supervised by members of the faculty and often, though not necessarily, forms the basis for the master’s thesis or doctoral dissertation.

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**

The program of study for the Master of Science degree involves at least 30 credit hours of graduate study. There are two options for Master of Science study: Plan A candidates for the Master of Science degree write a master’s thesis. Their program should include at least 6 but no more than 12 credit hours of research in their 30-hour program. Plan B candidates are required to take a comprehensive master’s examination and their program of study may contain up to 6 credit hours of research and directed reading.

Every MS degree candidate (including those who are on their way to a PhD degree) 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 Signal/Image Processing, Biomedical/Ultrasound, Solid-State Electronics, Optoelectronics, VLSI/IC Microelectronics Design, Computer Design, Musical Acoustics and Signal Processing, and Communications. For a list of approved courses for the successful completion of each concentration, refer to the electrical and computer engineering department curriculum guide or your advisor.

In addition, at least 24 credit hours must be at the 400 level or higher and at least 12 of these must be in electrical and computer engineering, exclusive of research or reading courses. Furthermore, at least 18 credit hours of graduate study must be earned in electrical and computer engineering courses numbered at the 200 level or higher. (No more than two 200- or 300-level courses are permitted in the overall program.) To be successful in the graduate program, the student must have a strong background in mathematics. An electrical and computer engineering faculty member should be consulted if such a deficiency is perceived, and appropriate coursework should be identified to build competency before proceeding with the formal program of study.

**The MS exam**

All Plan B (non-thesis option) full-time and part-time students must pass an MS exam. The exam must be conducted by a committee of no less than two ECE faculty members. The Plan A (thesis option) exam committee must also contain a member from an external department. It is the responsibility of each MS student to work closely with his or her advisor in selecting a committee. The Graduate Committee can assist with this, if needed. The MS exam committee will decide on the form of the MS exam for each student. The MS exam is an exit exam, that is, students should plan on taking it toward the end of their study. The deadlines for completion of the Plan A and Plan B final examination requirements—oral, written, or essay—for each degree conferred are listed in the “Graduate Calendar for the College.” Plan A candidates may not defend their thesis until all other degree requirements are completed.

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.

Students should notify the department’s Graduate Coordinator when they are beginning to plan for their exit exam.

**PhD Program**

The PhD degree requires 90 credit hours of graduate study (60 credit hours beyond the master’s degree), including 45–50 credits of coursework. Students are encouraged to begin research early in their programs. The comprehensive examination, taken during the first year of study, 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 in 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.

**GRADUATE COURSES**

**400. Computer Organization**

Set principles; processor design, pipelining, data and control hazards; datapath and computer arithmetic; memory systems; I/O and peripheral devices; internetworking. Students learn the challenges, opportunities, and tradeoffs involved in modern microprocessor design. Assignments and labs involve processor and memory subsystem design using hardware description languages (HDL).

**401. Advanced Computer Architecture**


**402. Advanced Topics in Memory Systems**

Performance modeling, design, and analysis of computer systems using queuing theory. Topics include operational laws, Markov chains, networks of queues, techniques to deal with nonexponential workload distributions, and scheduling. The course emphasizes applications to computer architecture and software systems.
404. Multiprocessor Architecture

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. Advanced Digital Design Using FPGA

Review of complex embedded project development with Xilinx Virtex FPGA evaluation 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. GPU Parallel Programming Using C/C++

GPU micro-architecture, including global memory, constant memory, texture memory, SP, SM, scratchpad memory, L1 and L2 cache memory, multiported 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-Uniform 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. Advanced GPU Project Development

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 their progress and a 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.

409. Machine Learning

(Same as CSC 446)

This course presents the mathematical foundations of AI, including probability, decision theory, and machine learning.

421. Optical Properties of Material

(Same as OPT 421)

Optical properties of electrons, phonons, plasmons, and polaritons in semiconductors, metals, and insulators are detailed.

423. Semiconductor Devices


424. Introduction to Condensed Matter Physics

(Same as PHY 420)

The course is designed for students of physical science or engineering background who are interested in biological and medical physics. Topics include fundamentals of biological physics, diffusive motion in biological system, thermal equilibrium and steady state, forces and energetics in biology, biochemical reaction, corporative transitions, biological membranes, neural system, and biophysical techniques. The materials are presented at the level of Nelson Biological Physics.

426. Waveguides and Optoelectronic Devices

(Same as OPT 468)

Propagation and interactions in optical waveguides. Topics include the Goos-Hänchen effect, coupled-mode theory, pulse broadening in optical fibers, coupling between guided-wave structures, and wave-guide devices such as semiconductor lasers, fiber lasers, and optoelectronic devices.

427. Electric Power: Conversion, Transmission, and Consumption

Important elements of electric power, from conversion to consumption. How the principal sources of energy—coal, natural gas, impounded water (hydroelectric), and fissile materials—are exploited to create electric power, how it is distributed through the grid, and then how it is consumed. Informed analysis of the true prospects and technological challenges of new energy sources, such as biomass, wind power, and oil shale, and assessment of the opportunities to improve distribution and usage efficiency through a Smart Grid.

428. Radiation and Detectors

(Same as OPT 425)

The course covers thermal radiation, radiometry, photometry, and colorimetry and surveys several types of detectors.

429. Audio Electronics

(Same as AME 223)

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 op-amps, large-signal design and analysis methods including an overview of linear and switching power amplifiers and power supply design. 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. Low-noise audio equipment design principles including proper grounding and shielding techniques are also covered.

431. Computational Methods

Basic computational techniques for the numerical solution of these problems on computers. This process involves the conversion of physical problems into mathematical boundary-value
problems, the approximation of continuous problems as discrete problems, and numerical inversion of systems of equations. Applications in acoustic and electromagnetic wave propagation and scattering are presented as motivation. Students are encouraged to adapt the techniques to their own research interests and are expected to develop basic computer programs implementing the discussed algorithms.

432. Acoustical Waves
Introduction to acoustical waves. Topics include 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
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.

435. Introduction to Optoelectronics
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. Nanophotonic and Nanomechanical Devices
This course aims to provide students with the understanding of fundamental principles governing optical and mechanical phenomena at micro/nanoscale, with focus on current research advances on device level. The following topics are 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.

440. Introduction 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.

441. Detection and Estimation Theory
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 Cramér-Rao inequality, maximum likelihood estimation; nonparametric estimation of CDFs.

444. Digital Communications
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
Concepts behind traditional cellular radio and wireless data networks (e.g., channel coding, medium-access) as well as design trade-offs among RF bandwidth, transmitter and receiver power and cost, and system performance. An in-depth look at modern cellular systems, wireless local area and personal area networks, ad-hoc data networks, and sensor networks. Topics include medium access control, routing, flow control, and cross-layer architectures. Issues such as quality of service (QoS), energy conservation, reliability and mobility management are discussed.

446. Digital Signal Processing
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. Image Processing

448. Wireless Sensor Networks
This course covers the latest research in the area of wireless sensor networks. The course discusses all aspects of these unique and important systems, from the hardware and radio architecture through protocols and software to applications. Topics 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. Students must complete a semester-long course project related to wireless sensor networks.

449. Machine Vision
(Same as CSC 249/449)
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. Information Theory**

Entropy, relative entropy, mutual information, asymptotic equipartition property, data compression, channel capacity, joint source channel coding theorem, Gaussian channels, rate distortion theory, selected applications.

**451. Biomedical Ultrasound (Same as BME 251/451)**

This 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 nonthermal biological effects of ultrasound, ultrasonography, dosimetry, hyperthermia, and lithotripsy.

**452. Medical Imaging—Theory and Implementation**

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.

**455. Software Analysis and Improvement (Same as CSC 255/455)**

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 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.

**457. Digital Video Processing**

Basics of digital video, digital video filtering, and video-based object recognition and tracking. Core topics 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 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.

**461. Intro to VLSI**


**462. Advanced CMOS VLSI Design**

Review of CMOS subsystem design. Team project on complex digital systems, such as a simple microprocessor, a self-timed multiplier, or a digital filter. Project design requirements include architectural design, logic and timing verification, layout design, and test pattern generation. The resulting VLSI chips may be fabricated.

**463. VLSI Error Control Systems**

This course reviews the reliability challenges introduced by the multi-core billion-transistor integration era and discusses circuit, architectural, and algorithm 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.

**466. RF and Microwave Integrated Circuits**

Analysis and design of radio-frequency (RF) and microwave integrated circuits at the transistor level. Smith chart, s-parameters, and EM simulation. High-frequency narrow-band amplifiers, wideband amplifiers, low-noise amplifiers (LNA). Nonlinear circuits, oscillators and phase noise, phase-locked loops (PLL) and frequency synthesizers.

**467. Analog Integrated Circuit Design**


**468. Advanced Analog CMOS Integrated Circuit Design II**

469. High-Speed Integrated Electronics
An introduction course for state-of-the-art integrated electronics in high-speed and wideband applications, which spans the fields of wireless communications, computing, fiber optics, and instrumentation. The course emphasizes the understanding of basic circuit operation and the development of circuit design intuition.

471. Computational Music
(Same as AME 471)
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.

472. Topics in Musical Sound Synthesis and Processing
(Same as AME 472)
Acoustics and Digital Signal Processing techniques applied to the analysis and synthesis of musical sound. Topics include sampling, quantization and audio quality metrics, time-frequency analysis and sound representations, audio filter design and implementation, musical sound synthesis techniques including spectral-based synthesis and physical modeling, and additional special topics based on class interests.

473. Computational Models of Music
(Same as CSC 263 and AME 263)
This course explores 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. Focus is on the symbolic level of music representation rather than on the signal level (there will be no signal processing in this course). Most assignments consist of reading articles and answering questions about them. There are some programming assignments, with other options for students without programming ability.

474. Biomedical Sensors, Circuits, and Instrumentation
(Same as BME 474)
Course covers circuits and sensors used to measure physiological systems at an advanced level. Both signal conditioning and sensor characteristics are addressed. Topics include measurement of strain, pressure, flow, temperature, biopotentials, and physical circuit construction. The corequisite laboratory focuses on the practical implementation of electronic devices for biomedical measurements. Graduate students are also responsible for a research paper and a 20-minute class presentation on the topic of the paper.

475. Audio Software Design
(Same as AME 262)
The aim of this course is to give students the ability to develop their own audio/music programs in C/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/C++ language, the course explores the topics of programming for digital audio signal processing and sound synthesis: audio streams, digital audio signals, time and frequency domain programming, and audio plug-in architectures. The second half of the course introduces mobile audio programming for iOS and Android systems and presents the primary techniques of sound design using the audio programming environments of Csound, SuperCollider, and Pure Data. Students practice their programming techniques through a series of programming assignments and a final project.

476. Audio Software Design II
(Same as AME 264)
This course is a sequel to AME 262/ECE 475 Audio Software Design. The first half of the course begins with an overview of the C++ language and then explores two major topics: programming for audio signal processing and designing audio effect plugins. The second half of the course focuses on audio programming for iOS and Android. Students will learn how to make musical apps and game audio. The course will have programming assignments and a final project.

479. Audio Recording—Technology and Fundamentals
This course covers the acoustical and psychoacoustic fundamentals of audio recording including the nature of sound, equipment used in typical recording studios, signal flow, analog to digital conversion, and DSP software plug-in use. The course also provides practical experience in audio recording using Pro Tools–based workstations. Students are required to complete a substantive recording project at the end of the course.

491. Reading Course in Electrical and Computer Engineering (MS)
Credit to be arranged
Supervised reading on topics beyond those available in existing courses or on specialized topics.

492. Special Topics
For a current listing of these courses, please view the departmental website.

493. Master’s Essay
Please see the faculty advisor or graduate coordinator for more information regarding this option.

494. Master’s Research Internship

495. Research in Electrical and Computer Engineering (MS)
Credit to be arranged
496. Special Projects Course in Electrical and Computer Engineering (MS)  
Credit to be arranged

520. Spin-Based Electronics  
Basic physics of magnetism and of quantum mechanical spin. Aspects of spin transport with emphasis on spin-diffusion in semiconductor. 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 Electrical and Computer Engineering (PhD)  
Credit to be arranged  
Supervised reading on topics beyond those available in existing courses or on specialized topics.

594. PhD Research Internship

595. Research in Electrical and Computer Engineering (PhD)  
Credit to be arranged

Materials Science

Professors Bigelow, Bocko, Boyd, Burns, Chen, Chimowitz, Conwell, Dewhurst, Donaldson, Funkenbusch, Jacobs, T. Jones, Krauss, Lambropoulos, B. L. Miller, Prezhdo, Quesnel, Rolland, Rotberg (Chair), Sobolewski, Waugh, Wicks, Wu  
Associate Professors Anthamatten, Awad, Guo, McGrath, M. Z. Yates  
Assistant Professors Benoit, DeLouise, Dery, Grossfield, Mukaibo, Nilsson, Shestopalov

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 nanostuctures 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 58 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 MS 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 six 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 202, Introduction to Materials Science, which is a three-credit-hour course for graduate students. All first-year graduate students are required to register for the Materials Science Graduate Seminar Series (MSC 496).
Students interested in working towards materials science degrees have a wide range of courses from which to draw in constructing their programs of study. Students are expected to develop their particular program in consultation with their thesis advisor. The current list of MSC courses is provided below. Note that the 200-level courses carry three credits, and that the 400- and 500-level courses carry four credits unless noted otherwise.

202. Introduction to Materials Science
(Same as ME 280)
Prerequisites: ME 226, PHY 122.
Properties of engineering materials including metals, alloys, ceramics, polymers and composites. Relationship of properties to the materials microstructure including atomic bonding, atomic arrangement, crystal structure, co-existing phases, interfaces, defects and impurities. Processing techniques for altering the microstructure and properties.

230. Thermodynamics and Statistical Mechanics
(Same as PHY 227)
Prerequisites: PHY 237, MTH 281 or ME 201 (MTH may be taken concurrently).
Multiplicity of physical states, equilibrium entropy and temperature, Boltzmann factor and partition function, statistical approach to free energy, chemical potential, distribution functions for ideal classical and quantum gases. Applications to chemical reactions, thermal engines, equations of state and phase transitions, applications.

402. Bio-Physical Chemistry I
(Same as CHM 402)
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 nonspecialists to become conversant in the language and principles of the field, as well as to understand the strengths and limitations of various techniques.

403. Characterization Methods in Materials Science—Diffraction
(Same as ME 451)
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.

404. Bio-Physical Chemistry II
(Same as CHM 404)
Prerequisite: CHM 252 or equivalent.
Credit—two hours
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.

405. Thermodynamics of Nano and Microsolids
(Same as ME 460)
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 solids including stress and strain variables.

407. Solids and Materials Lab
(Same as ME 462)
Prerequisites: ME 280, 226.
In this course, students apply previously learned theoretical concepts to practical problems and applications. In addition, they learn experimental techniques and enhance their technical writing skills. This course has two parts, a series of small laboratory exercises and a project. During the semester, students 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 are useful to a broad base of engineering problems. The project portion is where students work on a more specific idea, tailored around their desired future goals.

408. Microstructure
(Same as ME 463)
Prerequisite: ME 280.

409. Mechanical Behavior of Solids
(Same as ME 481)
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, (γ) 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).

413. Engineering of Soft Matter
(Same as CHE 413)
Prerequisites: CHM 203 (or equivalent) and CHE 225 or CHM 251 (or equivalent).

This course provides an overview of several contemporary research topics pertaining to structured organic materials. Lectures focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials.

416. X-Ray Crystallography
(Same as CHM 416)
Prerequisites: CHM 211, 411, or 415; understanding of symmetry operations.
Credit—two hours

In this course students learn the basic principles of X-ray diffraction, symmetry, and space groups. Students also experience the single crystal diffraction experiment, which includes crystal mounting, data collection, structure solution and refinement, and the reporting of crystallographic data.

418. Statistical Mechanics
(Same as PHY 418)
Prerequisites: PHY 227 or equivalent; PHY 407, 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.

420. Biological Physics
(Same as PHY 420)
Prerequisites: PHY 227, 237 or permission of instructor

The course is designed for students of physical science or engineering background who are interested in biological and medical physics. Topics include fundamentals of biological physics, diffusive motion in biological system, thermal equilibrium and steady state, forces and energetics in biology, biochemical reaction, corporative transitions, biological membranes, neural system, and biophysical techniques. The materials are presented at the level of Nelson Biological Physics.

423. Semiconductor Devices
(Same as ECE 423)
Prerequisites: ECE 221, PHY 123 or permission of instructor.


424. Introduction to Robust Design and 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. Optomechanics
(Same as ME 432)

The mechanical design and analysis of optical components and systems are studied. Topics 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 is placed on integrated analysis, which includes the data transfer between optical design codes and mechanical FEA codes.

433. Polymer Science and Engineering
(Same as CHE 486)
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.

436. Molecular Spectroscopy and Structures
(Same as CHM 458)
Prerequisite: CHM 451 or equivalent.
Credit—two hours

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 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.

442. Microbiomechanics
(Same as BME 442)
Prerequisite: permission of instructor.

This course covers the application of mechanical principles to biotechnology and to understanding life at its smallest scales. Topics 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.
445. Biomaterials
(Same as BME 445)
Prerequisites: CHM 131, 132, PHY 121, 122, MTH 161, 162, Biomechanics and BIO 110, or permission of instructor.

This course provides a background in biomaterials: 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.

448. Controlled Release Systems
(Same as BME 448)

This course is designed to provide students with an understanding of the principles, strategies, and materials used in controlled drug delivery systems. The course first covers the fundamentals of drug delivery, including physiology, pharmacokinetics/pharmacodynamics, drug diffusion and permeation, and biomaterials used in drug delivery. Controlled release strategies for various administration routes are then discussed.

449. Elasticity
(Same as ME 449)
Prerequisites: ME 226, 163 or MTH 163.

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. 3D problems via potentials.

451. Biomedical Ultrasound
(Same as BME 451)

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 nonthermal biological effects of ultrasound, ultrasonography, dosimetry, hyperthermia, and lithotripsy.

454. Interfacial Engineering
(Same as CHE 454)
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, micelles, microemulsions, and colloidal dispersions.

455. Thermodynamics and Statistical Mechanics
(Same as CHM 455)
Prerequisite: CHM 251 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 noninteracting quantal systems are expressed in terms of partition functions, for gases of simple and complex particles. Nonequilibrium statistical behavior of multi-particle systems leads to diffusion and other transport phenomena.

456. Chemical Bonds—from Molecules to Materials
(Same as CHM 456)
Prerequisite: CHM 251 or equivalent course on 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 discusses materials of all length scales from individual molecules to macroscopic three-dimensional crystals, but focuses on zero-, one-, and two-dimensional inorganic materials at the nanometer scale. Specific topics include semiconductor nanocrystals, quantum wires, carbon nanotubes, and conjugated polymers.

458. Electrochemical Engineering and Fuel Cells
(Same as CHE 458)
Credit—two hours

This course concentrates 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 students for the challenges of energy conversion and storage and the environment in the twenty-first century.

460. Solar Cells
(Same as CHE 460)

This course introduces 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 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 are a part of the coursework.

461. Fracture and Fatigue
(Same as ME 461)
Prerequisites: ME 280, 226.

462. Cell and Tissue Engineering  
(Same as BME 462)  
Prerequisites: knowledge of chemistry, mass transfer, fluid mechanics, thermodynamics, and physiology.

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 five 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.

463. NMR Spectroscopy  
(Same as CHM 423)  
Prerequisites: one year of organic chemistry and one semester of physical chemistry (CHM 251) or equivalents.  
Credit—two hours

In this course, students are introduced to NMR spectroscopy. Collection, processing, and interpretation of homonuclear and heteronuclear 1D and multidimensional spectra are covered. Topics discussed include chemical shifts, relaxation, and exchange phenomena. Examples from organic, inorganic, and biological chemistry are used.

464. Fundamentals of Lasers  
(Same as OPT 424)  
Fundamentals and applications of laser systems, including optical amplification, cavity design, beam propagation and modulation. (For non-optics/physics graduate students.)

465. Principles of Lasers  
(Same as OPT 465)  
Topics include quantum mechanical treatments to two-level atomic systems, optical gain, homogeneous and inhomogeneous broadening, laser resonators, cavity design, pumping schemes, rate of equations, and Q-switching for various lasers.

468. Chemical Kinetics  
(Same as CHM 460)  
Prerequisite: CHM 451 or equivalent.  
Credit—two hours

Within the broad area of chemical kinetics, this course focuses on basic concepts of kinetics, photochemistry, and electron-transfer (eT). In addition to studying bulk reaction rates, the course also covers Marcus's theory of eT, intramolecular vibrational energy redistribution (IVR) and vibrational cooling, and the fates of photoexcited species (radiative and nonradiative decay channels). Also addressed are the experimental quantification of these kinetics using time-resolved spectroscopy and analysis of kinetic data. The course material is somewhat continuous with that of CHM 458, Molecular Spectroscopy.

469. Biotechnology and Bioengineering  
(Same as CHE 469)  
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. Optical Properties of Materials  
(Same as OPT 421)  
Optical properties of electrons, phonons, plasmons, and polaritons in semiconductors; metals and insulators are detailed.

471. Optical Fabrication and Testing  
(Same as OPT 443)  
Characteristics and properties of optical glass and the methods for fabricating high-quality surfaces and components. Lectures describe applications of such glass in laser systems and nonlinear optics.

472. Biointerfaces  
(Same as CHE 492)  
The course focuses on interfacial phenomena in hybrid bioorganic systems. The goal of the course is to increase the understanding of interactions between biomolecules and surfaces. The course aims 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 focuses on mechanisms of interactions between biomolecules and surfaces. The second part focuses on the characterization of physical, chemical, and morphological properties of biointerfaces.

473. Introduction to Optoelectronics  
(Same as ECE 235)  
Prerequisites: ECE 230 and 221 or 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.

474. Nano-Optics  
(Same as OPT 463)  
Prerequisites: OPT 461, 412.

Examination of theory of strongly focused light, confocal and near-field optical microscopy, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, and optical forces.
482. Processing Microelectronic Devices
(Same as CHE 482)
Credit—two hours
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, microolithography, thermal processing, chemical vapor deposition, etching and ion implantation, and damascene processing.

484. Microelectromechanical Systems
(Same as ECE 434)
Prerequisites: MTH 163, 164, PHY 122 (or equivalents).
Static and quasistatic fields for microelectromechanical transducers and certain microfluidic schemes. Capacitance models, lumped parameter electromechanics, and two-port device descriptions. Reciprocity and sensitivity issues.

485. Thermodynamics and Statistical Mechanics
(Same as CHE 485)
In the beginning, macroscopic thermodynamics including phase equilibria and stability concepts are covered, followed by material related to the principles of statistical mechanics. Applications to various modern areas of the topic are examined including the Monte Carlo simulation method, critical phenomena, and diffusion in disordered media.

491. Master’s Reading Course in Materials Science
Supervised reading and study on topics generally not covered in existing formal courses.

492. Special Topics in Materials Science
A lecture or seminar course at the master’s level on topics of current interest.

ECE 492. Special Topics in Physics and Application of Nanophotonic and Nanomechanical Devices
Prerequisites: basic knowledge about electromagnetic waves, waveguides, optoelectronics, and quantum mechanics.
This course aims to provide students with the understanding of fundamental principles governing optical and mechanical phenomena at micro/nanoscale, with focus on current research advances on device level. The following topics are 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; physics and application of optical and mechanical phenomena at mesoscopic scale; state-of-the-art devices and current research advances.

493. Master’s Essay in Materials Science
Supervised preparation of the master’s essay for Plan B candidates.

495. Master’s Research in Materials Science

496. Materials Science Graduate Seminar

507. MSC Seminar Practicum
(Same as OPT 407)
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
(Same as ECE 520)
Prerequisites: permission of instructor and familiarity with elementary quantum mechanics.
Basic physics of magnetism and of quantum mechanical spin. Aspects of spin transport with emphasis on spin-diffusion in semiconductor.

541. Nanoscale Crystalline Defects
(Same as ME 541)
This course is a thorough study of the means by which defects in crystalline lattices control the observable macroscopic properties of single phase materials. The properties under consideration are mechanical properties, electrical properties, optical properties, and chemical properties. The defects of interest include point, line, and planar defects, including charged defects that determine internal friction, yield strength, transparency and translucency, chemical potential, stored energy, electrical resistivity, dielectric response. Knowledge of how such defects determine important engineering properties of solids is a fundamental requisite for all areas of materials research.

552. Special Topics in Materials Science
Subject matter to be selected by the instructor from among topics of current interest in materials science.

(Same as ECE 580)
Prerequisite: permission of instructor.
Introduction to the scientific foundations of nanoscience and the materials science that makes it possible to focus on developments in three major domains of applications, electronics, photonics, and biosensing.

591. PhD Reading Course in Materials Science
Supervised reading on topics beyond those available in existing courses, or on specialized topics.

592. Special Projects in Materials Science

595. PhD Research in Materials Science

Mechanical Engineering

Professors Betti, Burns, R. Clark, Funkenbusch, *Genberg, Gracewski, Lambropoulos (Chair), McCrory, Meyerhofer, Perucchio, Quesnel, Ren
Assistant Professors Aluie, Ellis, Kelley, Nam
Assistant Professor (Research) Guazzotto
Adjunct Assistant Professors *Goncharov, *Maximov, Myatt
Joint Appointments: Professor Waugh; Associate Professor Lerner
Lecturers Davies, Muir, Rice, *Ronald, Theobald
Professors Emeriti A. Clark Jr., Gans, Goldman, Li, Simon, Thomas

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), and the Institute of Optics in the College.


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 batteries and other energy technologies; ocean mixing and its role in the planetary carbon cycle; two-dimensional turbulence; fundamentals of scalar mixing; advection-diffusion-reaction in chaotic and turbulent flows. 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, is 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 emphasized are found in the section on the Materials Science Program (page 142).

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 Problems**  
*Prerequisites: MTH 164 and 163 or 165*

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 is used extensively. Prior knowledge of Mathematica is helpful but not essential. In the last two weeks of the course, there is a project on an assigned topic. The course includes applications in heat conduction, electrostatics, fluid flow, and acoustics.

**401. Methods of Applied Mathematics**  
*Prerequisites: ME 201 or MTH 281; MTH 282.*

Advanced ordinary differential equations (ODEs), boundary layer theory, WKB method, multiple-scale analysis, asymptotic expansion of integrals, renormalization group.

**402. Partial Differential Equations**  
*Prerequisites: ME 201 or MTH 281 and ME 202/MTH 282.*

Green’s functions and eigenfunction expansions; application to the Laplace, diffusion, and wave equations. First-order equations and the theory of characteristics; Green’s functions for wave propagation; dispersive waves. Boundary layers and matched asymptotic expansions.

**403. Computational Methods for Engineering and Science**  
*Prerequisite: ME 402 or PHY 401 or OPT 411, or permission of the instructor. Some FORTRAN experience desirable.*


**404. Computational Methods Applied to Biological Systems**  
*Prerequisites: MTH 163, 165*

Computational methods to solve analytically intractable mathematical problems in biological research. Using MATLAB as a programming language; numerical methods for linear algebra, ODE, and PDE; case studies such as biodynamics of human locomotion, ion channel kinetics, ionic diffusion in cells, and finite element analysis of cells/tissues.

**406. Dynamical Systems**  
*Prerequisite: MTH 165.*

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.

**407. Advanced Dynamics**  
*Prerequisites: ME 121, 213, and ME/MTH 163.*

Review of principles of mechanics; generalized coordinates and constraints; calculus of variations; Lagrange’s equations; Hamilton’s equations; rigid body dynamics; applications.

**408. Phase Transformation in Metals and Alloys**  
*Prerequisite: ME 460.*

The physical, chemical, and mechanical properties of metals and alloys can be varied drastically by thermal and mechanical
treatments. This phase transformation course is concerned with a description of how atomic rearrangements occur and how they are associated with kinetic and crystallographic features.

411. Mechanical Properties of Polymers  
Prerequisite: permission of the instructor.
Structure of polymers, elastic behavior, finite strain elasticity, viscoelastic behavior of polymers, time-temperature superposition, free volume theory, relaxation processes, nonlinear and anisotropic behavior, yielding and fracture.

424. Introduction to Robust Design and Quality Engineering  
Prerequisite: MTH 164 or equivalent.
Definition and pursuit of “quality” as a design criterion. The concept of robust design. Selection of the quality characteristic and experimental design to improve quality. Cross-listed as ME 212, but requires significant extra work.

431. Computational Methods  
Prerequisites: MTH 280 or equivalent, ECE 230 or equivalent, or permission of the instructor.
Computational Methods covers basic computational techniques for the numerical solution of these problems on computers. This process involves the conversion of physical problems into mathematical boundary-value problems, the approximation of continuous problems as discrete problems, and numerical inversion of systems of equations. Applications in acoustic and electromagnetic wave propagation and scattering will be presented as motivation. Students are encouraged to adapt the techniques to their own research interests and are expected to develop basic computer programs implementing the discussed algorithms.

432. Optomechanics  
Prerequisites: ME 226 and 204.
Design of structures to support optical components such as lenses, mirrors and telescopes for UV, visible and IR optical applications. Extensive use of finite element methods in optomechanical design and optimization.

434. Introduction to Plasma Physics I  
Prerequisite: EE 231 or PHY 217.
Orbit theory, adiabatic invariants, collective effects, two-fluid and MHD equations, waves in plasma, transport across magnetic fields and in velocity space.

435. Introduction to Plasma Physics II  
Prerequisite: ME 434.
Vlasov equation, Landau damping, Van-Kampen modes, shield clouds, two-stream instability, microinstabilities, drift instability, nonlinear instability theory, radiation from plasma.

436. Compressible Flow  
Prerequisites: ME 225 and ME 201 or MTH 281.
Equations of motion, acoustics; linearized equations for homogeneous media; mathematical theory of linear waves; geometrical acoustics. Nonlinear simple waves, Riemann invariants. Finite amplitude compressible flow; one-dimensional waves and the theory of characteristics; shock waves; steady two-dimensional flow. Dimensional analysis, self-similar flows. Combustion and detonation.

437. Incompressible Flow  
Prerequisites: ME 225 and ME 201 or MTH 281.
Conservation equations, Bernoulli’s equation, Navier-Stokes equation. Inviscid flows; vorticity; potential flows; stream function; complex potential. Viscosity and Reynolds number; some exact solutions with viscosity; boundary layers; low Reynolds number flows. Selected applications from aerodynamics. Waves.

440. Mechanics of Structures  
Prerequisite: ME 226.
Application of direct and indirect methods of the calculus of variations to the stress, deflection, and dynamic analysis of beam, ring, plate, and shell elements. Strain energy and complementary strain energy; variational principles; Lagrange multipliers. Rayleigh-Ritz method; Galerkin method; Reissner’s variational principle.

441. Finite Elements  
Prerequisites: ME 226 and programming capability in Matlab.
The theory and application of finite element analysis to linear problems in structural mechanics and other disciplines. Topics: matrix analysis concepts; element formulation methods; element behavior; global analysis aspects; isoparametric elements. Term project requires the implementation of a finite element program in MATLAB.

443. Applied Vibrations  
Prerequisite: ME 213.
One, two, and many degrees-of-freedom systems. Complex representation; free and forced vibration; transient vibration; damping. Vibration of strings, beams, and membranes.

444. Continuum Mechanics  
Prerequisites: ME/MTH 164, ME 201, ME 225, ME 226.

445. Plates and Shells  
Prerequisites: ME 226, ME 201 or MTH 281.
Analysis of stress and deformation in rectangular and circular plates bent by transverse loads. Axisymmetric deformation of shells of revolution. Asymptotic expansions; membrane and bending stress. Application to pressure vessels, tanks, and domes with various support and load conditions.
446. Wave Propagation in Elastic Media
Prerequisites: ME 121, 226; ME 201 or MTH 281.
Physical phenomena (reflection, dispersion) and mathematical
techniques (Green’s functions, Fourier analysis, stationary phase)
are studied for waves on strings. Concepts are then used to study
waves in infinite, semi-infinite, and layered structures and waves
in layers and cylinders.

448. Structural Stability
Prerequisite: ME 226. Strongly recommended: ME 201 or MTH 281.
Concepts of equilibrium and stability of deformable solid struc-
tures. Applications to elastic columns, plates, and shells. Interac-
tions with fluids. Static and dynamic systems.

449. Elasticity
Prerequisites: ME 226; ME/MTH 163.
Analysis of stress and strain; equilibrium; compatibility; stress-
strain relations. Torsion and bending of bars. Plane stress and
plane strain; Airy stress functions. Half-plane problems. 3-D
elasticity; Papkovich-Neuber, Love potentials. Applications to
problems for the half-space.

450. Optimum Design
Prerequisites: ME 226, ME 204 (or equivalent), and some
programming experience.
Nonlinear programming techniques are applied to optimize
the mechanical design problem. Both constrained and uncon-
strained techniques are discussed. Students use state-of-the-art
software to solve a variety of problems. The combination of opti-
mization with finite elements is addressed.

451. Crystallography and X-Ray Diffraction
Prerequisite: permission of instructor.
Crystallography, symmetry elements, point groups, space groups,
X-ray diffraction, single crystal diffraction, powder patterns,
Fourier transforms, grain size effects, residual stress and cold
work, diffuse and small-angle scattering, Bragg and Laue, X-ray
topography. Weekly laboratory.

452. Electron Microscopy
Prerequisites: ME 451 and permission of instructor.
Microstructural features and their effect on mechanical, elec-
trical, and optical properties. Point, line, and planar defects;
kinematical theory of diffraction; reciprocal space; single crystal
diffraction patterns; dynamical theory of diffraction; direct ob-
servations of dislocations and stacking faults. Weekly laboratory
involving use of electron microscope.

453. Intro to Nuclear Engineering
A first course in nuclear engineering with emphasis on the fun-
damental 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. Nonlinear Finite Element Analysis
Prerequisite: ME 441 or equivalent.
The theory and application of nonlinear finite element analysis
in solid and biosolid mechanics. Topics: generalization of FE
concepts, review of solid mechanics, nonlinear incremental
analysis, displacement-based FE formulation for large displace-
ments and large strains, nonlinear constitutive relations, incom-
pressibility and contact conditions, hyperelastic and viscoelastic
materials, biomechanical materials, solution methods.

459. Applied Finite Elements
Prerequisite: ME 441 or permission of instructor.
The course addresses practical topics in finite elements, including
vibrations, buckling, structural symmetry, superelements, and
fracture mechanics. Modeling techniques and applications to
problem solving are stressed using commercial FEA codes.

460. Thermodynamics of Solid Materials
Prerequisite: ME 123 or CHE 225.
Review of basic thermodynamic quantities and laws; phase
transformations and chemical reactions; partial molar and excess
quantities; electrochemical reactions; free energy of binary sys-
tems; surfaces and interfaces; nucleation of neophases; stressed
solids; irreversible thermodynamics.

461. Fracture and Fatigue
Prerequisites: ME 280, 226, and 442.
Linear elastic fracture mechanics. Griffith theory. K and J approaches
to toughness measurements. Low-cycle fatigue. Crack nucleation and
fatigue crack growth. Failure analysis. Emphasis on the role of micro-
structure in determining fracture and fatigue behavior. This is a course
taught to bring the student at or near the level of current research.

462. Solids and Materials Laboratory
(Same as ME 242, but requires significant extra work.)
Prerequisite: permission of instructor.
Design, planning, execution, and reporting of laboratory experi-
ments, including both existing experiments and a significant
independent research project.

463. Microstructure
Prerequisite: ME 280.
Diffusion-induced stresses. Dislocation walls and pileup.
Disclinations. Surfaces and interfaces. Precipitates and inclusions.

466. Electrochemistry and Corrosion
A scientific approach to understanding and thereby controlling me-
tallic corrosion. Starting from general principals of materials science,
this course explores the physics that controls chemical degradation.
483. Biosolid Mechanics
Prerequisite: ME 226.
Application of engineering mechanics to biological tissues including soft tissue and bone. Experimental and computational methods and material models of biological structures.

491. Reading Course on Mechanical Engineering
Credit to be arranged
Supervised reading on topics beyond those available in existing courses, or on specialized topics. The students in general make a thorough search and study of the literature dealing with the current research in a given field.

492. Precision Engineering
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. Precision engineering pushes the current state of the art into new frontiers. The goal of this course is to develop a fundamental understanding of the tools and techniques used for designing, assessing, and ultimately implementing precision systems.

493. Master’s Essay
Supervised preparation of the master’s essay for Plan B candidates.

495. Research in Mechanical Engineering
Credit to be arranged

532. Magnetohydrodynamics
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. Alfvén 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.

535. Laser-Plasma Interactions
Prerequisite: ME 434 or permission of instructor.

536. Hydrodynamic Stability
Prerequisites: ME 434 and 435 or permission of instructor.

537. Advanced Topics in Fluid Mechanics
Credit—two to four hours
Content of the course varies from year to year, but may include such topics as perturbation methods in fluid mechanics, flow phenomena involving ionizing, dissociating, or reacting gases, higher approximations in boundary layer theory, the study of water waves, rotating flows, and solar magnetohydrodynamics.

540. Advanced Topics in Materials Science
Credit—two to four hours
Topics vary from year to year. Examples are as follows: deformation of amorphous solids, dislocation dynamics, defect mechanisms in polymers, micromechanics of fracture and fatigue, structure and properties of grain boundaries and interfaces, disclinations, deformations of glasses with applications to optics manufacturing.

544. Advanced Topics in Solid Mechanics
Credit—two to four hours
Content of the course varies from year to year but may include such topics as advanced experimental design, wave propagation, nonlinear elasticity, biomechanics, composite materials, and finite elements.

545. Advanced Topics in Plasma Physics
Credit—two to four hours
The course content varies from year to year but includes topics which introduce the student to problems of immediate interest in the field. Examples are controlled fusion reactor concepts, including laser fusion, energy in the future, space plasmas, and astrophysical plasma phenomena.

591. Reading Course in Mechanical Engineering
Credit to be arranged
Supervised reading on topics beyond those available in existing courses, or on specialized topics.

595. Research in Mechanical Engineering
Credit to be arranged
The Institute of Optics

Professors Agrawal, Boyd, Brown, Fienup, George, Knox, Moore, Novotny, Rolland, Stroud, Teegarden, Wicks, Williams, Zhang (Director)
Associate Professors Alonso, Bentley, Berger, Guo, Zavislan
Assistant Professors Ellis, Vamivakas
Assistant Professors (Research) Bentley, Marcianete
Adjunct Professor Walmsley
Adjunct Assistant Professors Berg, Buralli, Kruschwitz, Nelson, Oliver
Joint Appointments: Professors Bigelow, Eberly, Foster, Jacobs, Krauss, Wolf; Associate Professors Seka, Yoon
Lecturer McIntyre
Senior Scientist Lukishova, Vorobyev
Professor Emeritus Thompson

The Institute of Optics is devoted to teaching and research in optics and optical engineering. It offers 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, ultra-high 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 the Test of English as a Foreign Language (TOEFL) are required of foreign applicants, unless they are graduates of a U.S. undergraduate program.

Catalog supplements providing the most recent information on course content and faculty research may be obtained on request from the Institute of Optics.

PhD Program

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 the students to devote full time to coursework. Four courses are taken each semester. The purpose of the first year’s work is to provide a broad background in optical physics and engineering. Courses include Mathematical Methods for Optics, OPT 411; Geometrical and Instrumental Optics, OPT 441, 442; Optical Radiation and Detectors, OPT 455; Fourier Optics, OPT 461; Electromagnetic Waves, 462; and Quantum Mechanics for Optics, OPT 412. 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 some area of specialty in preparation for PhD research and begin their PhD research. During the second year, students usually fulfill their teaching requirement, which is two semesters of service. This service is required whether or not the students have received financial support from the University. Students are required to take not less than 12 hours of courses during this year. At least eight hours of their coursework should be at the 500 level (and as indicated in the Optics Graduate Handbook, some 400-level courses that have other 400-level courses as prerequisites qualify as 500-level courses for this purpose).

The requirements are the core requirements listed above, one or two additional 400-level optics courses, thesis research and written MS thesis, and successful final defense of the MS thesis. Credit for the thesis may not be less than 6 nor more than 10 hours.

MS Program

The master’s degree program is designed to provide students who have a strong undergraduate preparation in physics, electrical engineering, or optics with the 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 credit hours is required for the degree. Normally, no more than 10 hours are accepted as transfer credits, and those must be approved by the Graduate Committee and the associate dean for graduate studies. The MS in optics is available to both full-time and part-time students. As outlined under general University regulations in this bulletin, the optics MS can be pursued under either Plan A or B. There is a required set of core courses common to all options within the MS program: Geometrical and Instrumental Optics, OPT 441; Physical Optics, OPT 461 or 462; a laboratory course, OPT 456; and Radiation and Detectors, OPT 455. The laboratory course is not required for part-time students. The remaining credits are obtained by taking elective courses or through research credits. The grade point average of all courses counted toward the degree must be “B” or greater.

The various options and exceptions to these general rules are described below.

Plan A: The requirements are the core requirements listed above, one or two additional 400-level optics courses, thesis research and written MS thesis, and successful final defense of the MS thesis. Credit for the thesis may not be less than 6 nor more than 10 hours.
Plan B: The standard requirements are the core requirements listed above, one additional course in physical optics, one additional course in quantum optics, one additional course in geometrical optics, one additional course to reach a total of 30 semester hours, and a research essay. The elective courses are normally 400-level specialized courses in optics. Also available is an alternative set of requirements that enables a more concentrated study in certified specialty areas, such as Optical Communications, Nonlinear Optics, Optical Materials, Laser Engineering, Medical Optics, Image Science, Optical Design and Testing, and Business Administration. For more information, see the Optics Graduate Handbook available from the Institute of Optics.

BS-MS Program

Undergraduate juniors majoring in optics may apply for admission into a five-year program leading to both a BS and an MS degree in optics. Students apply for admission into this program in the spring of their junior year and can begin graduate-level coursework during the senior year. Students must meet all of the requirements for the BS degree as well as those for the MS degree. Students may follow the master’s thesis (Plan A) or the non-thesis (Plan B) route.

The thesis route is particularly recommended as it allows the student to develop a very high level of expertise in a specialized field of optics.

The normal fourth- and fifth-year programs for students in this program:

**FOURTH YEAR**

OPT 441 or 461
OPT 223*
OPT 425
Optics Elective

OPT 442 or 462
OPT 256*
Elective (technical or free)
Elective (distribution)
Elective (techn or free)

**FIFTH YEAR**

OPT 441 or 461
Optics Elective
Optics Elective
Optics Elective

OPT 442 or 462
Optics Elective
Optics Elective
Optics Elective

BS-MS students following a Plan B program will satisfy the regular requirements for the BS degree as well as those for the MS degree but will normally substitute more advanced electives in place of some of the core courses.

To apply, students must be in good academic standing and have completed all of the required courses through the first semester of the junior year. Students may also compete with other MS candidates for financial aid in the fifth year.

**MS Cooperative Program**

The curriculum and requirements for this program are the same as those for our regular program. The program, admission to which is subject to the approval of the Graduate Committee, consists of three blocks: (1) a four-month semester at the University of Rochester; (2) a 12-month period spent working in industry; and (3) a second four months at the University of Rochester to complete the master’s program.

In order for students to participate in the work block of the program, they must satisfactorily complete the academic block. Failure to do so will result in termination from the program.

Students will, of course, have to fulfill the normal conditions of employment at the various corporations (these conditions may include, for example, passing a health examination, signing nondisclosure agreements, etc.). During the work block, students are paid wages comparable to those of other employees with similar educational backgrounds and experience.

During the time students are employed in industry, they are registered for 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.

**Part-Time Master’s Programs**

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 MS regulations in this bulletin for information concerning maximum time limits, retroactive credit, and transfer credit.

Students in the part-time program usually do not write an MS thesis and are not required to take OPT 456.

**456. Optics Laboratory**

Intensive laboratory course, with experiments on optical imaging systems, diffraction, interference, holography, lasers, detectors, spectroscopic instruments, and optical communication systems.

**407. Scanning Electron Microscopy 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.

**411. Mathematical Methods for Optics**

*Prerequisites: ME 201, 202 or equivalent, and permission of instructor.*

Study of mathematical techniques such as vector calculus, series expansions, contour integration, integral transforms (Fourier, Laplace, and Hilbert), asymptotic estimates, and second order differential equations.
412. Quantum Mechanics for Optics
Prerequisite: one course in undergraduate wave mechanics or permission of instructor.
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 operators. The quantum mechanics of simple systems, including the harmonic oscillator, spin, and the one-electron atoms, are reviewed. Also, methods of calculation useful in modern quantum optics are discussed. These include manipulation of coherent states, the Bloch sphere representation, and conventional perturbation theory.

421. Optical Properties of Materials
Prerequisite: undergraduate quantum mechanics.
The course concerns the aspects of the solid-state physics of materials, which influence their optical properties. Semiconductors are emphasized, but metals and insulators are treated also. The physics of optical absorption, emission, reflection, modulation, and scattering of light is covered. Optical properties of electrons, phonons, plasmons, and polaritons are detailed. The optical properties of reduced dimensionality structures such as quantum wells are contrasted with those of bulk semiconductors.

424. Fundamentals of Lasers
Prerequisite: permission of instructor. Not available for optics and physics graduate students.
Fundamentals and applications of lasers and laser systems, including optical amplification, cavity design, beam propagation, and modulation. Emphasis is placed on developing the basic principles needed to design new systems, as well as an understanding of the operation of those currently in use.

425. Radiation and 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.

427. Optical Liquid Crystals
This course introduces the materials, terminology, effects, and devices used in the field of liquid crystal optics. Basic structures in nematic and cholesteric liquid crystals are 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 are 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 are covered. Other applications explored include mood rings, polarizing pigments for document security, smart windows, and car paint.

428. Optical Communications
The course is designed to give the students a basic understanding of modern optical communication systems while making them aware of the recent technological advances. The following topics are covered: analog and digital signals, multiplexing techniques, modulation formats, dispersive and nonlinear effects in optical fibers, light-emitting diodes and semiconductor lasers, receiver design, noise and signal-to-noise ratio, bit error rate, optical amplifiers, dispersion management, multichannel systems, soliton systems, coherent lightwave systems.

432. Opto-Mechanical Design
The mechanical design and analysis of optical components and systems are studied. Topics 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-optics and stress-optics (stress birefringence) effects. Emphasis is placed on integrated analysis, which includes the data transfer between optical design codes and mechanical FEA codes. A term project is required.

441. Geometrical Optics
This course is designed to give the student a basic working knowledge of image-forming optical systems. The course is oriented toward problem solving. Material covered includes image formation, paraxial and real ray-tracing, and first-order properties of systems; matrix formulation of paraxial optics, magnification, F/number, and numerical aperture; stops and pupils, telecentricity vignetting; telescopes, microscopes, the eye and visual systems, field lenses; optical glasses, the chromatic aberrations, and their correction; derivation of the monochromatic wavefront and transverse ray 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; field flatteners, introduction to aberration tolerances, and image quality assessment.

442. Geometrical 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. Optical Fabrication and Testing
This laboratory and lecture course is designed to give a firsthand working knowledge of optical glasses, their properties, and the methods for fabricating and characterizing high-quality glass surfaces and components. Lectures emphasize the physical and optical properties of glass, methods for manufacturing glasses, the component finishing process (grinding and polishing), cleaning, finished element specification, chemical durability, and optical quality evaluation methods. New glasses and their applications in laser systems and nonlinear optics are described. The laboratory is designed to expose the student to several varieties of optical glasses, the methods for cold working glass blanks, and the fabrication and testing of selected optical elements. Hands-on activity with grinding and polishing equipment is required to complete one of a variety of projects.

444. Lens Design
Prerequisite: OPT 441.
The course begins with a review of geometrical optics and third-order aberration theory. Then lens design specification documents and image assessment (ray intercept plots, wavefront analysis, spot diagrams, MTFs, and point spread functions) are discussed. Additional topics in lens design to be covered include optimization theory, damped least squares, global optimization, merit functions, variables, and constraints; glass, plastic, UV, and IR materials; aspheres, GRINs, and diffractive optics; secondary spectrum, spherochromatism, higher order aberrations and induced aberrations; splitting and compounding lens elements; aplanats and anastigmats. The following refractive design forms are discussed in detail: landscape lens, achromatic doublet, Cooke triplet, Double Gauss, Petzval lens, wide-angle, telephoto, and eyepieces. The following reflective design forms are also covered: parabola, Cassegrain, Schmidt, Ritchey Cretian, Gregorian, three-mirror anastigmat, and reflective triplet. Computer-aided lens design exercises are required using commercially available software including a one-week midterm design project and a four-to-six week individual lens design project at the end of the semester.

445. Precision Engineering
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. 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.

446. Optical Interference Coating Technology
This course addresses the design, manufacture, and quality control of optic interference coatings. Topics covered include reflection and transmission at an interface; the vector diagram; the Smith Chart; properties of periodic media; design of high reflectors, bandpass filters, and edge filter; use of computer programs for design analysis; production techniques; thickness monitoring; thickness uniformity calculations.

447. Advanced Optical Interference Coatings
Prerequisite: OPT 246/446 or permission of instructor.
This course covers such topics as the effects of dispersion, scatter, and inhomogeneity in multilayer interference coating designs. Attention is given toward manufacturability of designs and meeting common optical specifications. Design assignments address fields including, but not limited to, ophthalmic, lighting, display, infrared applications, lasers, and telecommunications. Each student is given access to current market design, optical characterization, and post-process analysis software.

448. Vision and the Eye
The human visual system is the most sophisticated imaging system known. This course reveals the intricate optical and neural machinery inside the eye that allows us to see. It describes 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. The course compares the human eye with the acute eyes of predatory birds and the compound eyes of insects. The course also describes 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 sciences, but is recommended for anyone with a curiosity about vision or an interest in biomedical applications of optics. The course also serves as an introduction to the study of vision for graduate students.

OPT 449. Instrumentation and Methods for Vision Research
(Same as CVS 541)
This course describes the design, construction, and operation of optical instrumentation used in modern vision research. Various techniques for delivering stimuli to the retina, including Maxwellian view optics and CRT displays, are discussed. Methods of calibrating these systems are described in the context of a practical treatment of radiometry, photometry, and colorimetry. The course also covers optical techniques for monitoring the retina (optical coherence tomography), monitoring eye position (Purkinje eye tracking), and monitoring the brain (infrared reflectance imaging).

OPT 450. Polarization
Prerequisites: OPT 441 and 461 or permission of 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 calculus, ellipsometry, polarization in multilayers and gratings, principles of polarization ray-tracing, polarization effects in focusing and imaging, polarization metrology, and topics in polarization coherence.
452. Medical Imaging—Theory and Implementation
(Same as ECE 452)
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-computer tomography, and MRI.

453. Quantum Optics and Quantum Information Lab
This laboratory course exposes students to cutting-edge photon counting instrumentation and methods with applications ranging from quantum information to biotechnology and medicine. It is based on quantum information, the new exciting application of photon counting instrumentation. As much as wireless communication has impacted our 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 are 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 are outlined in the course materials as possible applications of these concepts and tools.

456. Chemical Bonds: Molecules and Materials
An introduction to the electronic structure of extended material systems from both a chemical bonding and a condensed matter physics perspective. The course discusses 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.

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.

462. Electromagnetic Waves
Prerequisites: undergraduate electromagnetic theory, advanced calculus, and vector analysis.
This course covers topics in electromagnetic theory that serve as a foundation for classical descriptions of many optical phenomena. A partial list of topics include 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; and optical waveguides.

464. Physics and Application of Nanophotonic and Nanomechanical Devices
Prerequisites: ECE 230 or OPT 262 or 462, ECE 235/435 or OPT 226 or 468, OPT 223 or 412 or PHY 237 or 407.
This course aims to provide students with the understanding of fundamental principles governing optical and mechanical phenomena at micro/nanosopic scale, with focus on current research advances on device level. The following topics are covered: fundamental concepts of micro/nanosopic 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.

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, and various gas, liquid, and solid-state lasers.

467. Nonlinear Optics
Prerequisites: OPT 461 or 462.
Fundamentals and applications of optical systems based on the nonlinear interaction of light with matter. Topics 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.

468. Waveguide Optoelectronic Devices
This course covers the propagation and interactions in optical waveguides. Topics covered include the Goos-Haenchen effect; modes of the planar waveguide; coupled-mode theory; modes of 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-optic devices.

470. Biomedical Microscopy
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.
Biomedical Optics
Prerequisite: 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 optics is the study of how light is used to study biological systems, to obtain medical information, and to perform clinical procedures. Major topics in this course include biophysical spectroscopy (absorption, fluorescence, Raman, and elastic scattering), propagation of photons in highly scattering media (such as tissue), and techniques for high-resolution imaging in biological media: confocal imaging, multiphoton imaging, and optical coherence tomography. (Fall, even years)

Technical Entrepreneurship
Presentations by guest speakers. The primary requirement for the course is the development of a business plan for a start-up that integrates the various organizational functions of a company. See website (www.optics.rochester.edu) for more information.

System Integration and Product Development
Prerequisites: OPT 425, 441, and 461, or permission of instructor.

This class explores the ISO 9000 product development process and illustrates how to use this process to develop both products and research systems that meet necessary specifications. The class uses systems such as video projectors, CD-ROM drives, barcode scanners, and scanning laser microscopes as examples to illustrate the various concepts.

Reading Course in Optics (MS)
Credit to be arranged
Supervised reading and study on topics beyond those covered in existing formal courses.

Special Topics
A lecture or seminar course on topics of current interest. Current listings available on the department website.

Master’s Essay
Supervised preparation of a master’s essay for Plan B candidates.

Research in Optics (MS)
Credit to be arranged

Optical Interactions in Solids
This course consists of a sequence of lectures on topics in solid-state physics, which are necessary to understand the operation of optoelectronic devices. To balance the course between theoretical and experimental topics, each lecture commences with a 15-minute overview of a specific experimental technique or device that is related to the optical properties of solids. Lectures cover the following topics: optical constants of solids, electronic states, the role of lattice vibrations, a detailed look at optical transitions, and building devices.

Advanced Topics in Telecommunications
Prerequisites: OPT 461; OPT 428 recommended (but not required).

The course is designed to provide students with an understanding of the recent advances in the field of lightwave technology. The following topics are covered: dispersive and nonlinear effects in optical fibers; linear and nonlinear properties of fiber Bragg gratings, of fiber couplers, and of 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.

Advanced Lens Design
Prerequisite: OPT 444.

This course starts with a review of refractive optical design forms. The design of complex zoom lenses and multi-mirror reflective systems is discussed in detail starting with first principles. Other topics covered include optical design and materials for the ultraviolet and infrared wavelength bands, plastic optical systems, optomechanical design, tolerancing, sensitivity analysis, Monte Carlo analysis, environmental analysis, advanced optimization techniques such as user-defined and global optimization, ghost and stray light analysis, and illumination design. Students are required to complete two complex group design projects.

Introduction to Quantum Optics
(Same as PHY 531)
Prerequisite: OPT 412 or PHY 407/408 or permission of 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, Weissskopf-Wigner and Jaynes-Cummings models, the optical Bloch equations, resonant pulse propagation, homogeneous and inhomogeneous broadening, adiabatic and non-adiabatic transitions, and dressed states.

Quantum Optics I
Prerequisite: OPT 551 or permission of instructor.

This course is a continuation of Quantum Electronics I in which the basic theory developed in the first semester is applied to atomic and molecular systems. The topics covered include resonance fluorescence, superfluorescence, saturation spectroscopy, stimulated Raman scattering, multiphoton ionization, and other spectroscopic techniques of current interest.

Quantum Optics III: Atom-Field Interactions
(Same as PHY 533)
Prerequisite: OPT 551 or PAS 531 or permission of instructor.

Topics covered include the resonant interaction of atoms and quantized fields including spontaneous emission, the Lamb shift, resonance fluorescence, the quantum regression and fluctuations-dissipation theorems, quantum states of the field including squeezed states, Schrödinger cat states and bi-photons, entanglement in atom-field interactions, multiphoton ionization and other strong field effects, and wave packet physics.
554. Advanced Topics in Quantum Optics
Prerequisite: OPT 412 or PHY 407/408 or permission of instructor.

Several professors from the Institute of Optics and the Department of Physics and Astronomy (Alonso, Bigelow, Boyd, Eberly, Howell, and Stroud) deliver a two-double lecture sequence as an overview of their current research interests in quantum optics. Both experimental and theoretical topics are discussed. In addition, students carry out 6-hour laboratory experiments on generation and characterization of single and entangled photons (Lukishova). Grades [S (satisfactory) or F (failure)] are based on the evaluation of a homework problem set for each section of the course.

561. Advanced Imaging
Prerequisite: OPT 461.

This course covers advanced topics in imaging, concentrating on computed imaging; Fourier-transform-based imaging; and unconventional imaging, with emphasis on imaging through aberrating media (particularly atmospheric turbulence), in mathematical depth. Topics are selected from the following: stellar (speckle, Michelson, and intensity) interferometry, wavefront sensing for adaptive optics, phase diversity; pupil-plane lensless laser imaging, including 2-D and 3-D digital holography, imaging correlography, and X-ray diffraction imaging; Lyot coronagraphy, Fourier telescope, Fourier-transform imaging spectroscopy, structured-illumination superresolution, optical coherence tomography, extended-depth-of-field imaging, and synthetic-aperture radar. Additional topics suggested by the students are considered. The course also explores image reconstruction and restoration algorithms associated with these imaging modalities, including phase retrieval, Wiener-Helstrom and maximum likelihood deconvolution, multiframe blind deconvolution, dealiasing, side-lobe reduction, and phase-error correction algorithms. A project plus term paper, exploring an advanced imaging topic in depth, including computer simulations (or laboratory experiments) and implementing the image formation or restoration algorithms, are required.

563. Statistical Optics
Prerequisites: OPT 461 and 462; students are encouraged to take PHY 404 concurrently.


564. Theory of Optoelectronic Systems
Prerequisite: OPT 461.

With a definite systems orientation, topics in diffraction theory, coherence, signal processing, detection theory, digital image processing, spatial and frequency domain filtering, and statistical optics are studied as they apply to systems for imaging, digital cameras, and remote sensing. Regular problem sets are assigned together with request-for-proposal (RFP) topics so that the advanced graduate students obtain experience in the technical aspects of preparing systems proposals. Students prepare a final oral presentation (no other final examinations) to brief the class on a topic related to the course material. The course is a continuation of OPT 461–462.

591. Reading Course in Optics (PhD)
Credit to be arranged

Supervised reading and study on topics beyond those covered in existing formal courses.

592. Nano-Optics
Prerequisites: advanced calculus and vector analysis, electromagnetic theory, and quantum mechanics.

Nano-optics is an emerging new field of study motivated by the rapid advance of nanoscience and technology. The course addresses the key issues of optics on the nano-meter scale. Among the topics are theory of strongly focused light, confocal and near-field optical microscopy, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, and optical forces.

595. Research in Optics (PhD)
Credit to be arranged

596. Optics Colloquium
No credit

A series of talks on current research in optics, solid-state physics, and related fields. Speakers are visiting scientists, graduate students, and members of the faculty. Required each year of all graduate students in optics.
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 1Chen, 2Chimowitz, 3T. Foster, 5Jorné, 1Li, 2Schroder, 3Sobolewski, 3Tang, 3Wu, 5Yates (Director)
Associate Professors 2Anthamatten, 2Krauss
Assistant Professor 1Shestopalov
Adjunct Associate Professor 1D. Foster

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); the general requirements for these two options are described for existing Master of Science programs in Regulations and University Policies (see page 43). 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 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.

Coursework Requirements

To fulfill the credit-hour requirements, students should include a minimum of three core 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 listed as follows. With prior approval by the program director of graduate studies, equivalent graduate-level courses are accepted, and up to two undergraduate equivalents can be accommodated at three credit hours each.

CORE COURSES

441. Advanced Transport Phenomenon

This course acquaints 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 is to develop physical understanding of principles discussed with emphasis on chemical engineering applications. In addition to the text, the student is exposed to classic and current literature in the field. (Fall)

458. Electrochemical Engineering and Fuel Cells

The course concentrates 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 students for the challenges of energy conversion and storage and the environment in the twenty-first century. (Fall)

460. Solar Cells

This course introduces 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 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 are a part of the coursework. (Fall)
464. Biofuels
An overview of science, technologies, and processes relating to biomass as an alternative energy source, including the biological and thermochemical approaches. (Fall)

465. Thermochemical Biomass Conversion
Conversion of biomass to liquid fuels and chemical feedstocks traditionally derived from petroleum. Production of jet fuel, gasoline, and diesel fuel via gasification, liquefaction, pyrolysis, aqueous phase reforming, and transesterification of a variety of biomass. Generation of chemical platforms in support of food, drug, pharmaceutical, and polymer industries. Green chemistry and engineering aimed to improve sustainability of chemical conversions of a plethora of key intermediates originating from biomass. Use of environmentally benign solvents—such as ionic liquids, water, and supercritical carbon dioxide—in place of organic solvents. Catalytic chemical reactions with ball milling, microwave irradiation, and sonochemistry using minimum catalysts and solvents while maximizing reaction rates and yields for ease of product isolation and purification. Microreactor technology to maximize heat and mass transfer rates, reaction yields and product selectivities, and to facilitate process control, optimization, and scale-up. (Spring)

465. Thermodynamics and Statistical Mechanics
This course provides an introduction to the topic: Thermodynamics and Statistical Mechanics. In the beginning macroscopic thermodynamics including phase equilibria and stability concepts is covered followed by material related to the principles of statistical mechanics. Applications to various modern areas of the topic are examined including the Monte Carlo simulation method, critical phenomena, and diffusion in disordered media. The course requires completion of a project as well as regular homework assignments. (Spring)

TECHNICAL ELECTIVES

413. Engineering of Soft Matter
This four-credit graduate course provides an overview of several contemporary research topics pertaining to structured organic materials. Lectures focus on intermolecular interactions and the thermodynamics of self-assembly. Additional lectures introduce molecular crystals, polymer crystallinity, liquid crystals, self-assembled monolayers, surfactants, block copolymers, and biomimetic materials. Homework assignments and a brief technical presentation are required. Advanced undergraduate students are welcome.

430. Organic Electronics

454. Interfacial Engineering
The dynamic behavior of fluid interfaces. Concepts of interfacial stress, dynamic interfacial properties, and surfactant adsorption applied to surface tension driven flow, interfacial instabilities, the influence of surface-active agents on interfacial hydrodynamics, and the moving contact line.

469. Biotechnology and 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.

482. Processing Microelectronic Devices
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.

486. Polymer Science and Engineering
Mechanisms and kinetics of polymerization reactions; solution, suspension, and emulsion polymerization processes; thermodynamics of polymer solutions; the Flory-Huggins theory; principles and practice of membrane osmosmetry, light scattering, viscometry, and size exclusion chromatography; polymer rheology and mechanical properties; polymer morphology and phase transitions; electronic and photonic applications; recent advances in polymer science and technology.

CHM 456. Chemical Bonds: From Molecules to Materials
An introduction to the electronic structure of extended materials systems from both a chemical bonding and a condensed matter physics perspective. The course discusses materials of all length scales from individual molecules to macroscopic three-dimensional crystals, but focuses on zero-, one-, and two-dimensional inorganic materials at the nanometer scale. In the first half of the course, relevant language and concepts from condensed matter physics, such as a density of states and energy bands, are discussed but from a chemical bonding perspective. Students directly calculate electron energy states for materials at all length scales: from atoms and molecules to crystals in the solid state. In the second half of the course, the general concepts of electronic energy structure from the first half are applied to understanding the photophysics of nanometer scale materials, including quantum dots, nanocrystals, quantum wires, carbon nanotubes, and 1-D conjugated polymers. Given time, applications in several areas such as biological sensing and solar energy conversion are discussed.
CHM 462. Biological Chemistry
This course is a one-semester introduction to the chemical processes of life. Covered topics include proteins and nucleic acids, recombinant DNA technology, biological catalysis, and energy transduction. Structure and function of biological macromolecules are emphasized.

ECE 423. Semiconductor Devices
Prerequisite: permission of instructor.

ME 451. Crystallography and X-ray 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. Electron diffraction of single crystals and powder patterns.

ME 481. Mechanical Properties of Solids (school approval pending)
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.

PHY 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.

Technical Entrepreneurship and Management (TEAM)
Vice Provost for Entrepreneurship and Professor 4Moore Senior Associate Dean 7Hansen Professors 4Bocko, 4Thomas Associate Professors 7Ananthamatten, 8Ding, 4McGrath, 8Zavislan
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: degree requirements as stated in Regulations and University Policies (see page 35), 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; 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/](https://apply.grad.rochester.edu/apply/) by February 1. Supporting documents must be mailed to University of Rochester Center for Entrepreneurship, 1-211 Carol Simon Hall, P.O. Box 270360, Rochester, NY 14627-0160 or faxed to (585) 276-2135. For more information, please call (585) 276-3500 or visit [www.rochester.edu/team](http://www.rochester.edu/team).

REQUIRED ENTREPRENEURSHIP COURSES

401. Economics, Marketing, and Strategy Primer for Entrepreneurs
This course is designed to present fundamental concepts of microeconomics, marketing, and strategy, which will form the foundation for understanding the economic marketplace, and to provide the basis for assessing entrepreneurial opportunities. The course
begins with a study of consumer and firm behavior and the resulting demand and supply conditions in individual markets. Factors that affect market structure, prices, output levels, firm profitability, and consumer welfare are addressed in this context. A critical question facing entrepreneurs and others developing new products or services is determining whether the market potential for a product justifies the investment. Building on the economic model, the course explores marketing issues, in particular the value proposition for new products. The course concludes with an examination of strategies for both the development and marketing of new products and services. Topics include strategies for market entry (stand alone, joint venture, licensing), distribution policies, pricing policies, and product positioning.

402. Accounting and Finance Primer for Entrepreneurs
This course is designed to present the fundamentals of financial accounting and financial analysis that serve as a foundation for concepts developed throughout subsequent courses in the entrepreneurship program. The objectives of this course are to enable participants to understand and productively use the principles of finance and accounting information to better structure business decisions. The accounting 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 transaction analysis, cash vs. accrual accounting, financial statements, financial statement analysis, development of budgets and pro-forma financial statements, depreciation methodologies, and inventory methodologies. The financial module presents skills required to understand how companies make investment and financing decisions. Specific topics of discussion include calculation of net present values, an introduction to financial instruments, the tradeoff between risk and return in financial markets, capital budgeting and investment decision making, choosing an optimal capital structure, and using the weighted average cost of capital.

411. General Management of New Ventures
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 collaborate in the preparation of a business plan. The course includes time for students to share business ideas and identify possible team members. Each team has a coach who is an experienced businessperson. The coach is available to provide feedback to the team.

440. Screening Technical Opportunities
This course provides a process used to quickly assess the commercial merits of raw technologies. The 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, parse through approximately 150 technologies that are available for licensing. These are provisional, pending, and issued patents based upon research conducted at the University of Rochester and held by the Office of Technology Transfer. Teams select and “thicken” two technologies of interest. Thickening involves a cursory evaluation based upon technical merit, early market indicators, human resource availability, and business challenges. Teams 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 the TEM 441.

441. Product Development and Technical Management
In this class, students explore system engineering via 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 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, students 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 are dedicated to “brain-storming” solutions to technical problems and formal design reviews, where the students review the project plans of other students.

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. Professor Ronald Hansen will advise TEAM students on course selection, and 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/courses/.
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

Committees on Graduate Studies

Dean Rolf (Chair), Professors Barr, Cowdrick, Esse, Grunow, Humpherys, Laity, Lin, Liptak, Schindler, Silvey, Temperley, Terefenko, Van Demark, Watkins, Weinert, D. Ying

Faculty Offering Graduate Instruction

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
Tony Caramia, MM (SUNY, Fredonia)
Professor of Piano
Charles Castleman, MA (Pennsylvania)
Professor of Violin
Katherine Ciesinski, MM (Temple)
Professor of Voice
John Covach, PhD (Michigan)
Professor of Music Theory
Steven Daigle, MM (Florida State)
Professor of Opera
Harold Danko, BME (Youngstown)
Professor of Jazz Studies and Contemporary Media
Steven Doane, MM (SUNY, Stony Brook)
Professor of Violoncello
William Dobbins, MA (Kent State)
Professor of Jazz Studies and Contemporary Media
Jonathan Dunsby, 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
Richard Grunow, PhD (Michigan)
Professor of Music Education
Alan Harris, MM (Indiana)
Distinguished Professor of Violoncello
David Headlam, PhD (Michigan)
Professor of Music Theory
Benton Hess, BM (New England Conservatory)
Distinguished Professor of Voice
David Higgs, MM (Manhattan)
Professor of Organ
Douglas Humpherys, DMA (Rochester)
Professor of Piano
John Hunt, MM (Catholic)
Professor of Bassoon

Clay Jenkins, MM (Southern California)
Professor of Jazz Studies and Contemporary Media

Richard Killmer, DMA (Yale)
Professor of Oboe

Henry Klumpenhouwer, PhD (Harvard)
Professor of Music Theory

Mikhail Kopelman, (Moscow Conservatory)
Professor of Violin

Ellen Koskoff, PhD (Pittsburgh)
Professor of Ethnomusicology

Kim Kowalke, PhD (Yale)
Professor of Music

Oleh Krysa, (Moscow Conservatory)
Professor of Violin

Peter Kurau, MA (Connecticut)
Professor of Horn

Steven Laitz, PhD (Rochester)
Professor of Music Theory

Vincent Lenti, MA (Rochester)
Professor of Piano

David Liptak, DMA (Rochester)
Professor of Composition

Ralph Locke, PhD (Chicago)
Professor of Musicology

Patrick Macey, PhD (California, Berkeley)
Professor of Musicology

Elizabeth West Marvin, PhD (Rochester)
Professor of Music Theory

Robert McIver, DMA (West Virginia)
Professor of Voice

Honey Meconi, PhD (Harvard)
Professor of Musicology

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

Rebecca Penneys, Artist's Diploma (Indiana)
Professor of Piano

Carol Rodland, MM (Juilliard)
Professor of Viola

Marie Rolf, PhD (Juilliard)
Professor of Music Theory

Jamal Rossi, DMA (Rochester)
Professor of Woodwinds

Carlos Sanchez-Gutierrez, PhD (Princeton)
Professor of Composition

Mark Scattereday, DMA (Rochester)
Professor of Conducting and Ensembles

Allan Schindler, PhD (Chicago)
Professor of Composition

'Rita Shane, BA (Barnard)
Professor of Voice

Barry Snyder, MM (Rochester)
Professor of Piano

Robert Swensen, MM (Southern California)
Professor of Voice

James Thompson, BM (New England)
Professor of Trumpet

Jürgen Thym, PhD (Case Western Reserve)
Professor Emeritus of Musicology

Nelita True, DMA (Peabody)
Professor of Piano

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

Michael Anderson, PhD (Chicago)
Associate Professor of Musicology

Matthew BaileyShea, PhD (Yale)
Associate Professor of Music

Edoardo Bellotti, MM (Conservatory of Verona, Italy)
Associate Professor of Organ, Harpsichord, and Improvisation

Jeffrey Campbell, DMA (Rochester)
Associate Professor of Jazz Studies and Contemporary Media

Kathryn Cowdrick, MS (Columbia)
Associate Professor of Voice

Enrico Elisi, DMA (Peabody)
Associate Professor of Piano

Melina Esse, PhD (California, Berkeley)
Associate Professor of Musicology

Caterina Falli, MA (San Francisco State)
Associate Professor (Teaching) of English as a Second Language

Roger Freitas, PhD (Yale)
Associate Professor of Musicology

Kenneth Grant, BM (Rochester)
Associate Professor of Clarinet

Jean Guerrero, PhD (Harvard)
Associate Professor of Music Theory

Donald Harry, BM (Indiana)
Associate Professor of Tuba

Renée Jolles, MM (Juilliard)
Associate Professor of Violin

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

Glen Mackin, PhD (Washington)
Associate Professor of Political Science

'Jon Manasse, MM (Juilliard)
Associate Professor of Clarinet

William Marvin, PhD (Rochester)
Associate Professor of Music Theory

* Part-time
Seth Monahan, PhD (Yale)  
Associate Professor of Music Theory

Ayano Ninomiya, MM (Juilliard)  
Associate Professor of String Chamber Music

Jan Opalach, BM (Indiana)  
Associate Professor of Voice

Jean Pedersen, PhD (Chicago)  
Associate Professor of History

Ernestine McHugh, PhD (California, San Diego)  
Associate Professor of Religion and of Anthropology

Timothy Scheie, PhD (Wisconsin)  
Associate Professor of French

Reinhild Steingröver, PhD (SUNY, Buffalo)  
Associate Professor of German

George Taylor  
Associate Professor of Violin

David Temperley, PhD (Columbia)  
Associate Professor of Music Theory

Dariusz Terefenko, PhD (Rochester)  
Associate Professor of Jazz Studies and Contemporary Media

Holly Watkins, PhD (California, Berkeley)  
Associate Professor of Musicology

David Ying, DMA (California, Berkeley)  
Associate Professor of String Chamber Music

Janet Ying, BM (Rochester)  
Associate Professor of String Chamber Music

Phillip Ying, MM (Rochester)  
Associate Professor of String Chamber Music

Larry Zalkind, MM (Southern California)  
Assistant Professor of Trombone

Ricardo Zohn-Muldoon, PhD (Pennsylvania)  
Assistant Professor of Composition

Corbett Bazler, MA (Columbia)  
Assistant Professor of Musicology

Elena Bellina, PhD (New York University)  
Assistant Professor (Teaching) of Italian

Elizabeth Bucura, PhD (Arizona State)  
Assistant Professor of Music Education

Stephen Carr, MM (Rochester)  
Assistant Professor (Teaching) of Opera

John Fetter, PhD (Rochester)  
Assistant Professor of Music Education

Ted Goldman, PhD (Juilliard)  
Assistant Professor of Music Theory

Lisa Jakelski, PhD (California, Berkeley)  
Assistant Professor of Musicology

Jennifer Kyker, PhD (Pennsylvania)  
Assistant Professor of Musicology

José Oliveira Martins, PhD (Chicago)  
Assistant Professor of Music Theory

Seth Monahan, PhD (Yale)  
Assistant Professor of Music Theory

Rachel Remmel, PhD (Chicago)  
Assistant Professor of American Studies

Philip Silvey, EdD (Illinois, Urbana-Champaign)  
Assistant Professor of Music Education

Ann Marie Stanley, PhD (Michigan, Ann Arbor)  
Assistant Professor of Music Education

*Christel Thielmann, BA (York)  
Assistant Professor of Conducting and Ensembles

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, or music theory pedagogy. 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 and in ethnomusicology require a written thesis or a field project, and candidates are expected to show marked ability in research. The major in music theory pedagogy requires a teaching recital.

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), conducting (choral or instrumental), opera (performance or 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, 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 thesis in the form of an orchestral work or a large chamber work. 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 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

* Part-time
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 financial aid to a number of graduate students. These awards, which are made upon the recommendation of respective departments, are classified as teaching, research, departmental, or technical 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 may be renewed upon reapplication, 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/.

ACCOMPANYING CLASS (ACY)

405. Opera Coaching  
Prerequisite: permission of the instructor.  
Credit—one hour  
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 are 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. Strong interest in languages recommended. May be repeated for credit.

415. English Lyric Diction  
Credit—one hour  
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.

416. French Lyric Diction  
Credit—one hour  
Study of the basic rules of French lyric diction. Preparation and performance of French texts in musical settings. Intended for graduate piano accompanying majors; others by permission of instructor.

417. German Lyric Diction  
Credit—one hour  
Study of the basic rules of German lyric diction. Preparation and performance of German texts in musical settings. Intended for graduate piano accompanying majors; others by permission of instructor.

418. Italian Lyric Diction  
Credit—one hour  
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.

ACCOMPANYING (ACM)

430. Secondary Accompanying  
Credit—one and a half hours  
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.

460A. Primary Accompanying  
Credit—four hours  
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.

596. DMA Dissertation Project  
Credit—to be arranged
**APPLIED MUSIC LESSONS: SUMMER (AMU)**

**430.** Graduate Applied Music Lessons (half hour/week)
*Credit—one and a half hours*

May be used as a 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 four credits of applied music. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry two credits per semester.

**430A.** Graduate Applied Music Lessons (half hour/week)
*Credit—two hours*

Half-hour lessons in the student’s 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.

**BASSOON (BSN)**

**430.** Secondary Bassoon
*Credit—one and a half hours*

Graduate Applied Music Lessons (half hour/week): may be used as a 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.

**460A.** Primary Bassoon
*Credit—four hours*

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.

**ARTS LEADERSHIP CURRICULUM (ALC)**

**411 and 411K.** Entrepreneurship in Music
*Credit—one hour*

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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

**412 and 412K.** Entrepreneurship in Music
*Credit—two hours*

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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

**421 and 421K.** Leadership and Administration
*Credit—one hour*

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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

**422.** Leadership and Administration
*Credit—two hours*

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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

**431 and 431K.** Performance
*Credit—one hour*

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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

**432.** Performance
*Credit—two hours*

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 www.esm.rochester.edu/iml/alp/gradpolicy.php.
441. Contemporary Orchestral Issues  
Credit—one hour  
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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

451. The Healthy Musician  
Credit—one hour  
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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

452. The Healthy Musician  
Credit—two hours  
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 www.esm.rochester.edu/iml/alp/gradpolicy.php.

480. 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 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.

CHAMBER MUSIC (CHB)

401. Instrumental Sonata and Duo Repertoire  
Prerequisite: permission of instructor.  
Credit—two hours  
Intensive study of special topics from the instrumental and piano duo repertoire, selected at the beginning of the semester by the class. Open to graduate pianists, strings, and winds. May be repeated for credit. (Alternate years, alternating with 6CHB 403.)

402. Voice Repertoire for Pianists  
Credit—two hours  
An in-depth examination of specific areas of the vocal nonoperatic 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), and neglected repertoire. The class meets concurrently with CHB 431 or CHB 432 and addresses the repertoire from the dual perspective of singer and pianist. Required of master’s degree students majoring in Piano Accompanying and Chamber Music. Elective for DMA students in the Piano Accompanying and Chamber Music degree. Open to other keyboard majors with permission of the instructor. May be repeated for credit.

403. Piano Chamber Music Repertoire  
Prerequisite: permission of instructor.  
Credit—two hours  
Intensive study of chamber music repertoire in a performance class setting. The course is team taught by two members of the performance faculty. Up to eight preformed 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, and voice. May be repeated for credit. (Alternate years, alternating with 6CHB 403.)

431 and 432. Voice Repertoire, Master’s Level  
Credit—one hour  
A two-semester chronological survey of the most important vocal repertoire for the recital and concert stage from Caccini to the present. CHB 431 encompasses early Italian, English, French, and German art song up to circa 1900. CHB 432 continues from circa 1900 on and includes French melodie and a sampling of Spanish and Russian songs. In-class performance is emphasized in combination with outside listening and reading. The class addresses the repertoire from the dual perspectives of singer and pianist. Required of master’s degree students majoring in performance and literature-voice (two semesters) and in piano accompanying and chamber music (as CHB 402-1 or II). Open to other majors by permission of the instructor.

480. Graduate Chamber Music  
Credit—one hour  
Coaching and performance of chamber music for strings, piano, winds, and brass. Includes Music for All performances as well as in-house public performances. May be repeated for credit.
CLARINET (CL)

430. Secondary Clarinet
Credit—one and a half hours
Graduate Applied Music Lessons (half hour/week): may be used as a 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.

460A. Primary Clarinet
Credit—four hours
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.

490. Clarinet Choir
Credit—one hour

COMPOSITION (CMP)

401. Advanced Composition I
Prerequisite: CMP 204.
Credit—three hours
Intensive work in free composition for chamber groups and orchestra.

402. Advanced Composition II
Prerequisite: CMP 401.
Credit—three hours
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.

412. Compositional Practice circa 1925 to 1955
Credit—three hours
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 213); others by permission of the instructor. May be taken independently from CMP 413. Required for all Composition MM and MA students. (Alternate years)

413. Compositional Practice circa 1955 to 1980
Credit—three hours
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. (Alternate years)

421. Advanced Computer Music Techniques I
Prerequisite: CMP 225-6 or equivalent.
Credit—two hours
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.

422. Advanced Computer Music Techniques II
Prerequisite: CMP 225-6 or equivalent.
Credit—two hours
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.

440. Computer Engraving and Other Forms of Calligraphy
Credit—two hours
This graduate course is open to all students. It teaches 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 introduces students to the various popular notation programs, it provides in-depth instruction about one engraving program, and it includes several calligraphy projects. Undergraduate students should enroll in 6CMP 240.

490. Theory and Analysis of Contemporary Music

491-494. Composition Symposium (Graduate)
Credit—one hour
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 are 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.

495. MA Thesis
Credit—to be arranged
For the Master of Arts degree.
496. MM Thesis
Credit—to be arranged
For the Master of Music degree.

501. Advanced Composition III
Prerequisite: CMP 402.
Credit—three hours
Free composition, with emphasis on works for orchestra. Limited to candidates for the doctorate in composition. These courses may be repeated for additional credit.

502. Advanced Composition IV
Prerequisite: CMP 402.
Free composition, with emphasis on works for orchestra. Limited to candidates for the doctorate in composition. These courses may be repeated for additional credit.

591. What They Wrote
Prerequisite: Permission of instructor required.
Credit—three hours
Composition Research Seminar: Seminars on selected topics. Research and class discussion focus on technical, structural, analytical, and aesthetic issues salient or unique to the selected repertory under examination—the music of our own time.

595. PhD Dissertation Project
Credit—to be arranged

596. DMA Dissertation Project
Credit—to be arranged

CONDUCTING (CND)

213. Intermediate Conducting I (Instrumental)
Prerequisites: CND 212 or equivalent and permission of instructor.
Credit—two hours
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 and must be taken in sequence: CND 213, Intermediate Conducting I; CND 214, Intermediate Conducting II.

214. Intermediate Conducting II (Instrumental)
Prerequisites: CND 213 and permission of instructor.
Credit—two hours
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 and must be taken in sequence: CND 213, Intermediate Conducting I; CND 214, Intermediate Conducting II.

423. Choral Conducting II
Prerequisites: CND 223, 224, or equivalent and permission of the instructor.
Credit—two hours
Study of representative choral and choral/orchestral works of all periods. Emphasis is on the interpretation of scores and the development of refined professional conducting techniques.

424. Choral Techniques and Methods II
Credit—two hours
An extension of materials covered in CND 224, designed for the Master of Music degree in choral conducting.

431. Grad Choral Literature I
Credit—two hours
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. (Fall, alternating years between CND 431 and CND 432.)

432. Grad Choral Literature II
Credit—two hours
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. (Fall, alternating years between CND 431 and CND 432.)

441–444. Colloquy in Conducting
Credit—half hour
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.

461. Rehearsal Techniques I
Credit—two hours
Concentration on freedom of movement and manual dexterity along with development of score study habits. Class members prepare musical works from all periods of orchestral music for in-class discussion, trial, and review. Class study culminates in the leadership of the ESM Conducting Orchestra. May be repeated for credit.

462. Rehearsal Techniques II
Credit—two hours
Concentration on freedom of movement and manual dexterity along with development of score study habits. Class members prepare musical works from all periods of orchestral music for in-class discussion, trial, and review. Class study culminates in the leadership of the ESM Conducting Orchestra. May be repeated for credit.
481–484. Orchestral Conducting  
Prerequisite: CND 216 or the equivalent.  
Credit—three hours  
Focus on score study, gesture technique, and practical rehearsal procedure. Class sections focus on orchestral repertoire and preparing the student for regular sessions conducting the ESM Conducting Orchestra.

523. Choral Conducting III  
Credit—two hours  
For doctoral students majoring in conducting.

524. Choral Techniques and Methods III  
Credit—two hours  
For doctoral students majoring in conducting.

541. DMA Conducting I  
Credit—four hours  
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.

542. DMA Conducting II  
Credit—four hours  
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.

543. DMA Conducting III  
Credit—four hours  
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.

544. DMA Conducting IV  
Credit—four hours  
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.

596. DMA Dissertation Project  
Credit—to be arranged  

**DOUBLE BASS (DBL)**

430. Secondary Double Bass  
Credit—one and a half hours  
Graduate Applied Music Lessons (half hour/week): may be used as a 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.

460A. Primary Double Bass  
Credit—four hours  
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.

**ENSEMBLE (ENS)**

400. Graduate Ensemble  
Credit—one hour  
Instrumental ensemble for graduate students.

400J. Graduate Jazz Ensemble  
Credit—one hour  
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.

401. Graduate Ensemble  
Prerequisite: permission of the instructor.  
Credit—none  
Same as ENS 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.

401J. Graduate Jazz Ensemble  
( Same as ENS 400J, but for no credit and no charge)  
Credit—none  
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.

420. Graduate Chorale  
*Credit*—two hours

420A. Graduate Repertory Singers  
*Credit*—one hour

420B. Graduate Eastman Rochester Chorus  
*Credit*—one hour

420C. Graduate Women’s Chorus  
*Credit*—one hour

421. Graduate Chorale  
*(Same as ENS 420, but for no credit and no charge)*  
*Credit*—none  
For MM PRL voice students who need two semesters of vocal ensemble, but not the credit.

421A. Graduate Repertory Singers  
*(Same as ENS 420, but for no credit and no charge)*  
*Credit*—none  
For MM PRL voice students who need two semesters of vocal ensemble, but not the credit.

421B. Graduate Eastman Rochester Chorus  
*(Same as ENS 420, but for no credit and no charge)*  
*Credit*—none  
For MM PRL voice students who need two semesters of vocal ensemble, but not the credit.

421C. Graduate Women’s Chorus  
*(Same as ENS 420, but for no credit and no charge)*  
*Credit*—none  
For MM PRL voice students who need two semesters of vocal ensemble, but not the credit.

470. Conducting Ensemble  
*Credit*—none  
Conducting ensemble for “Graduate Award” contract holders only.
ETHNOMUSICOLOGY (ETH)

495. MA Thesis
Credit—to be arranged
Students design and implement a semester-long fieldwork project carried out in the Rochester area or another area of the student’s choice. The project results in a substantial paper and oral presentation. Projects are monitored by the department faculty.

502. Introduction to Ethnomusicology
Credit—four hours
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 are examined with an emphasis on listening and analytic skills. Assignments include reading, listening, video, and ethnographic projects, and a midterm and final exam.

EUPHONIUM (EUP)

430. Secondary Euphonium
Credit—one and a half hours
Graduate Applied Music Lessons (half hour/week): may be used as a 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 two credits per semester.

460A. Primary Euphonium
Credit—four hours
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 five credits per semester.

FLUTE (FL)

430. Secondary Flute
Credit—one and a half hours
Graduate Applied Music Lessons (half hour/week): may be used as a 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 two credits per semester.

460A. Primary Flute
Credit—four hours
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 five credits per semester.

GUITAR CLASS (GTC)

401 and 402. Seminar in Guitar Studies
Credit—two hours
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.

GUITAR (GTR)

430. Secondary Guitar
Credit—one and a half hours
Graduate Applied Music Lessons (half hour/week): may be used as a 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 two credits per semester.

460A. Primary Guitar
Credit—four hours
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 five credits per semester.

HARP (HRP)

430. Secondary Harp
Credit—one and a half hours
Graduate Applied Music Lessons (half hour/week): may be used as a 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 two credits per semester.

460A. Primary Harp
Credit—four hours
Graduate Applied Music Lessons (one hour/week): Used to fulfill a primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry five credits per semester.

HARPSICHORD (HPC)

430. Secondary Harpsichord
Credit—one and a half hours
Graduate Applied Music Lessons (half hour/week): may be used as a 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 two credits per semester.

460A. Primary Harpsichord  
Credit—four hours  
Graduate Applied Music Lessons (one hour/week): Used to fulfill a primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry five credits per semester.

HORN (HRN)

430. Secondary Horn  
Credit—one and a half hours  
Graduate Applied Music Lessons (half hour/week): may be used as a 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 two credits per semester.

460A. Primary Horn  
Credit—four hours  
Graduate Applied Music Lessons (one hour/week): Used to fulfill a primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry five credits per semester.

490. Natural Horn Studies  
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 is primarily Classical, although Baroque and Contemporary works may be examined.

JAZZ LESSONS (JAZ)

430. Secondary Jazz  
Credit—one and a half hours  
Graduate Applied Music Lessons (half hour/week): may be used as a 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 five credits per semester.

460A. Primary Jazz  
Credit—four hours  
Graduate Applied Music Lessons (one hour/week): Used to fulfill a primary lesson requirement for graduate students. For students who enrolled in their current graduate degree program prior to summer 2009, these lessons carry five credits per semester.

JAZZ STUDY AND CONTEMPORARY MEDIA (JCM)

224. Jazz Composition and Arranging II  
Prerequisite: JCM 223.  
Credit—two hours  
Basic techniques of writing for small jazz groups are presented and explored in relation to instrumental combinations of two to five wind and brass instruments with rhythm section. Homophonic and contrapuntal textures as well as melody harmonization techniques are studied in relation to a variety of harmonic styles. Students arrange a standard or an original theme.

225. Jazz Composition and Arranging III  
Prerequisite: JCM 224.  
Credit—two hours  
Basic techniques of writing for standard jazz ensemble instrumentation are presented and explored. Traditional approaches to orchestration, harmony, thematic development, and form are emphasized, as exemplified in jazz writers such as Neal Hefti, Ernie Wilkins, Frank Foster, Sammy Nestico, and Duke Ellington. Students arrange a standard from the jazz repertoire.

481 and 482. Special Topics in Jazz Studies and Contemporary Media  
Credit—two hours  
Specific topics and instructors are announced in advance. May be repeated for credit. Permission of instructor required.

407. Graduate Jazz Ensemble Direction  
Credit—one hour  
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.

431. Studio Orchestra Arranging  
Prerequisite: JCM 225.  
Credit—two hours  
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. Students’ works are read by the Eastman Studio Orchestra and selected works are performed on the orchestras annual concert.

451 and 452. Jazz Performance Workshop (Graduate)  
Credit—one hour  
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.)

**456. JCM MM Media Project**  
*Credit—none*  
Preparation and finalizing a media-related product that showcases the graduate student’s area of focus.

**484. Advanced Studies in Improvisation**  
*Prerequisite: permission of instructor.*  
*Credit—four hours*  
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.

**485 and 486. MM Writing Projects**  
*Prerequisite: permission of instructor.*  
*Credit—three hours*  
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.

**487 and 488. Advanced Studies: Jazz Composition**

**523. Harmonic Techniques**  
*Prerequisite: permission of instructor.*  
*Credit—three hours*  
A study of harmonic techniques and musical repertoire of 10 influential composers (Liszt, Debussy, Szymanowski, Scriabin, Schoenberg, Webern, Bartok, Berg, Messiaen, Shostakovich) and their relevance to jazz.

**524. Harmonic Techniques**  
*Prerequisites: JCM 523 and permission of instructor.*  
*Credit—three hours*  
A study of improvisational concepts (AD 800—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).

**551 and 552. DMA Jazz Performance Workshop**  
*Credit—one hour*  
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.

**596. DMA Dissertation Project**  
*Credit—to be arranged*  

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**KEYBOARD (KBD)**

**401. Sacred Music Skills I**  
*Credit—two hours*  
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 participate through weekly rehearsing of the class as choir. “Lab” time for honing students’ skills is available during the semester.

**402. Sacred Music Skills II**  
*Credit—two hours*  
Focuses on choral repertoire and anthem/motet planning and rehearsing. Students program anthems/motets for the church year (A, B, C) based on the Revised Common Lectionary. The course explores innovative ways to enhance the liturgy with music within the context of the evolution of liturgical practices. Students are 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 is available during the semester.

**403. Sacred Music Skills III**  
*Credit—two hours*  
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 aspects of church music administration. Students receive several individual “lab” coachings during the semester. Open to keyboard majors or by permission.
404. Sacred Music Skills IV  
*Credit—two hours*

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 repertoires are explored, and conducting techniques specific to younger participants are taught. In addition to assigned special projects, students 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.

405. Graduate Organ Improvisation  
*Prerequisite: TH 475, TH 476, or permission of instructor.*  
*Credit—one hour*

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 semiprivate lessons in small groups of two to four students.

411. Piano Literature I: Eighteenth Century  
*Credit—three hours*

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.

412. Piano Literature II: Nineteenth Century  
*Credit—three hours*

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.

413. Piano Literature III: Twentieth Century and Beyond  
*Credit—three hours*

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.

421. Organ Repertoire I  
*Credit—two hours*

A survey of solo organ repertoire, instrument-building traditions, and performance practice studies from antiquity through the seventeenth century.

422. Organ Repertoire II  
*Credit—two hours*

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.

423. Organ Repertoire III  
*Credit—two hours*

A survey of solo organ repertoire, instrument-building traditions, and performance practice studies from nineteenth-century Germany and France.

423. Organ Repertoire IV  
*Credit—two hours*

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.

442. Piano Repertory and Its Interpreters  
*Credit—three hours*

An intensive examination of a specific area of the piano repertoire; topics 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.
harmonization and the creation of jazz solo improvisations. Open to ESM majors only.

**461. Organ History, Design, and Maintenance**  
*Credit—two hours*

This course covers pipe organ functionality and design to include the major historic schools of organ building. It also includes practical tuning 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 students’ availability. Required for undergraduate organ majors. Open to others by permission of the instructor.

**LUTE (LUT)**

**430. Secondary Lute**  
*Credit—one and a half hours*

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.

**460A. Primary Lute**  
*Credit—four hours*

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.

**MUSIC HISTORY (MHS)**

**414. History of Jazz Styles**  
*Credit—three hours*

Investigation of performance and compositional innovations in jazz in the twentieth century. Analysis of scores, transcriptions, and recordings by major jazz stylists.

**421. Music in the Middle Ages**  
*Credit—three hours*

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 are 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.

**422. Music in the Renaissance**  
*Credit—three hours*

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 distinctive types of instrumental music. Overviews of political, artistic and social developments 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.

**423. Music in the Baroque**  
*Credit—three hours*

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 (1) expand students’ familiarity with baroque repertoire; (2) trace the origin and development of important genres; (3) locate baroque music in its historical and cultural contexts; (4) follow the general development of style; and (5) explore and understand the expressive languages employed by baroque composers. In addition to a midterm and final examination, the course requires one or two short writing assignments and one longer paper later in the semester.

**424. Music in the Classic Period**  
*Credit—three hours*

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 nineteenth 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.

**425. Music in the Nineteenth Century**  
*Credit—three hours*

This course not only deals with the history of musical style in nineteenth-century Europe, but it also explores music’s cultural contexts and social meanings. A study of the major genres of the era (symphony, Lieder, opera, piano miniatures, etc.) explores how music embodied social, political, and gendered meanings in both public and private spheres. The course introduces new works (as well as asks new questions about familiar pieces) and engages in close and careful analysis of sounds, scores, and the written word. The 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.
426. Music Since 1900  
Credit—three hours
This course is designed to provide a solid grasp of twentieth-century European and American art music by offering 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.

435. Concert Repertoire: Museum or Living Art?  
Credit—one hour
This course examines 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, the course explores 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 one elective credit as well as the listening exam requirement.

441. Baroque Performance Practice I  
Credit—two hours
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.

442. Baroque Performance Practice II  
Prerequisite: MHS 441 recommended.  
Credit—two hours
Dance music, tempo, tactus, ornamentation, improvisation, recitative, baroque opera practice, and a special session on performance practice issues in Bach, based on historical sources.

480. Bibliography  
Credit—two hours
A study of sources and reference materials in music.

481 and 482. Special Topics in Music History  
Credit—three hours
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 and Music; The Symphonies of Beethoven; Nineteenth-Century 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.

590. Research Seminars  
Credit—three hours
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; Nineteenth-Century 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 and Exoticism; twentieth-century Voice and Spectacle.

MUSIC EDUCATION (MUE)

402. Measurement and Evaluation  
Credit—three hours
This course reviews published aptitude and achievement tests and includes interpretation of test scores, administration of tests, and experience in developing tests.

403. Introduction to Research  
Credit—three hours
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.

404. The Psychological Foundations of Musical Behavior  
Credit—two hours
Although psychological issues are touched on in both the MUE 403 (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.

411. Early Childhood Music Education  
Credit—two hours
Orientation toward teaching music to children aged infant to eight 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).

412. Elementary General Music Methods
Credit—two hours
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).

413. Secondary General Music Methods
Credit—two hours
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.

414. Elementary and Middle School Choral Methods
Credit—two hours
In this course, preservice teachers 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.

415. High School Choral Music
Credit—two hours
In this course, preservice teachers 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.

419. Secondary Instrumental Rehearsals: Winds, Brass, Percussion
Credit—two hours
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 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, preservice 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.

420. Secondary Instrumental Rehearsals: Strings
Credit—two hours
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 30 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.
465. Instrumental Methods and Techniques: Wind and Percussion
Credit—three hours

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 hours of field experience are required for students pursuing Initial-Professional Certification.

466. Instrumental Methods and Techniques: Strings
Credit—three hours

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. Twenty-five hours of field experience are required for students pursuing Initial-Professional Certification.

471. Teaching Internship
Credit—two hours

Students are required to demonstrate competence in teaching and the application of concepts presented in other courses required by the MM or MA degrees in music education by submitting the following: (1) audio- and videotapes 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.

472. Teaching Internship for Certification
Credit—four hours

Supervised teaching experience for graduate students preparing for certification. Includes seminar.

473. MA Project
Credit—one to four hours

The specific nature of this master’s project is 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, students 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.

481, 482, and 483. Special Topics in Music Education
Credit—three hours

Designed primarily for graduate students, these courses offer intensive study of limited topic areas in music education and pedagogy. May be repeated for credit.

495. MA Thesis
Credit—to be arranged

For the Master of Arts degree.

501. History and Philosophy Seminar
Credit—three hours

Philosophy and history of music education, with emphasis on contemporary problems. Required of all graduate students in music education.

502. Curriculum Seminar
Credit—three hours

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.

503. College Teaching Internship
Credit—two hours

This course is related to one or more college-level courses that the student is presently teaching, either as a teaching assistant or as a faculty member at another college or university. Students are 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 observes teaching and meets with the students individually.

504. Preparing Future Music Faculty
(Same as ALC 222 and ALC 422)
Credit—two hours

This course prepares those graduate students who desire to teach in a college or community music school, even on a part-time basis. Students learn to develop a teaching portfolio that complements their performance portfolio. Students 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.

**505. Seminar in Academic Administration**  
*Credit—three hours*  
Topics and issues related to music administration in school, community, and higher education settings.

**506. Internship in Academic Administration**  
*Credit—two hours*  
*Prerequisite: MUY 505.*  
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.

**508. Cultural Perspectives in Music Education**  
*Credit—three hours*  
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 PhD students in Music Education. Others with teaching experience are admitted with the permission of the instructor.

**502. Introduction to Ethnomusicology**  
*Credit—four hours*  
This course charts the genealogies of thought over the last several centuries that inform our contemporary understanding of ethnomusicology. It provides 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. The course explores what it is that an ethnomusicologist does (or once did) by studying a variety of approaches to fieldwork methods and ethnographic representation. The course also explores several theoretical orientations, drawing from the disciplines of anthropology, linguistics, performance theory, media studies, and philosophies that inform the work of past and present ethnomusicologists and introduces 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.

**590. Research**  
*Credit—to be arranged*  
Independent investigation of problems in musicology. This course number is used by MM and DMA students enrolling in MUY four-credit seminars for three credits.

**591 and 592. Seminars in Musicology and Ethnomusicology**  
*Credit—four hours*  
Topics vary by semester. Recent offerings include Chansonniers, Opera in seventeenth-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 seventeenth-century Italian Cantata; Romantic Criticism and Aesthetics; National Styles and Exoticism, 1600–2006; nineteenth-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 cotaught by noted scholars from other departments at Eastman and in the College of the University of Rochester.

**591. Research for DMA Students**  
*Credit—to be arranged*  

**596. PhD Dissertation Project**  
*Credit—to be arranged*  
For the Doctor of Philosophy degree.

**596. DMA Dissertation Project**  
*Credit—to be arranged*  
For the Doctor of Musical Arts degree.

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**MUSICOLOGY (MUY)**

**501. Introduction to Musicology**  
*Credit—four hours*  
This course provides an introduction to the scope, bibliography, and prominent methodologies of musicology. To that end, it explores the history and development of the discipline, focusing especially on the current trends and their background; provides a practical introduction to the diverse sources of information in the field; and gives experience employing solid research and writing strategies.

**502. Introduction to Ethnomusicology**  
*Credit—four hours*  
This course charts the genealogies of thought over the last several centuries that inform our contemporary understanding of ethnomusicology. It provides 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. The course explores what it is that an ethnomusicologist does (or once did) by studying a variety of approaches to fieldwork methods and ethnographic representation. The course also explores several theoretical orientations, drawing from the disciplines of anthropology, linguistics, performance theory, media studies, and philosophies that inform the work of past and present ethnomusicologists and introduces 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.

**593. Directed Study I**  
*Credit—four hour*  
*Prerequisite: successful completion of Qualifying Exam or special approval of chair.*  
Required of PhD candidates in Musicology (and can be taken only by them).

**594. Directed Study II**  
*Credit—four hours*  
*Prerequisite: MUY 593.*  
Required of PhD candidates in Musicology (and can be taken only by them).

**595. PhD Dissertation Project**  
*Credit—to be arranged*
430. Secondary Oboe  
Credit—One and a half hours  
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 two credits per semester.

460A. Primary Oboe  
Credit—Four hours  
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 five credits per semester.

590. Baroque Oboe Studies  
Baroque Oboe Studies Goals: to develop familiarity with eighteenth-century oboes and performance practice. Students use Eastman’s extensive range of baroque and classical oboes, collected by Professor Killmer. Activities include technical studies, reed making, solo sonatas, chamber music, collaboration with keyboard and organ students, and oboe band. Six-hour private lessons plus ensemble and group work to be arranged with instructor.

OPERA (OP)

211. Opera Workshop I  
Study through exercises and performances of specific musical forms and acting techniques that aid the singing-actor in the dramatic presentation of all forms of lyric theater (from Baroque Opera to traditional Musical Theater). Additional musical and dramatic coaching may be required outside the normal weekly class meeting times. (Fall)

212. Opera Workshop II  
Study through exercises and performances of specific musical forms and acting techniques that aid the singing-actor in the dramatic presentation of all forms of lyric theater (from Baroque Opera to traditional Musical Theater). Additional musical and dramatic coaching may be required outside the normal weekly class meeting times. (Spring)

213. Early American Lyric Theater Survey and Performance Practicum  
Prerequisites: Two semesters of OP 209, 210; and/or permission of instructor.

A study of early American Musical Theater and American Operetta. The survey includes 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 and Hart and early Cole Porter also are studied. A survey of American Operetta includes works by Victor Herbert and Sigmund Romberg. Students sing ballads and ensembles from the shows covered within the course. The course culminates in a performance of a scenes program or musical review of the works studied in the class. This course may not be substituted for Opera Workshop 211 or 212. (Every other year)

214. The Play Without Music: Performance Practicum for Singers  
Prerequisites: Two semesters of OP 209, 210; and/or permission of instructor.  
Credit—one hour  
Exploration and performance of monologues and scenes selected from spoken theater. The monologues and scenes studied and rehearsed are based on course enrollment. Emphasis is given to contemporary theater (twentieth and twenty-first century). Research and written assignments are required. The course culminates in an informal performance of monologues and scenes studied in the class. This course may not be substituted for Opera Workshop 211 or 212. (Every other year)

401. Seminar in Lyric Theater Stage Directing  
Credit—Two hours  
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.

402. Seminar in Lyric Theater Stage Directing  
Credit—Three hours  
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.

410. Opera Production Project: Stage Management  
Prerequisites: Two semesters of OP 209, 210; two semesters OP 211–214; and/or permission of instructor.  
Credit—Two hours  
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.

411. Opera Workshop for Graduate Students  
Prerequisite: Permission of primary voice teacher and instructor.  
Credit—one hour  
Study, through exercises and performances of specific musical forms and acting techniques that aid the singing-actor in the dramatic presentation of all forms of lyric theater (from Baroque
Opera to traditional Musical Theater). Additional musical and dramatic coaching may be required outside the normal weekly class meeting times. (Fall)

412. Opera Workshop for Graduate Students
Prerequisite: permission of primary voice teacher and instructor.
Credit—one hour
Study, through exercises and performances of specific musical forms and acting techniques that aid the singing-actor in the dramatic presentation of all forms of lyric theater (from Baroque Opera to traditional Musical Theater). Additional musical and dramatic coaching may be required outside the normal weekly class meeting times. (Spring)

413. Early American Lyric Theater Survey and Performance Practicum
Prerequisites: two semesters of OP 209, 210; and/or permission of instructor.
Credit—one hour
A study of early American Musical Theater and American Operetta. The survey includes 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 and Hart and early Cole Porter are also studied. A survey of American Operetta includes works by Victor Herbert and Sigmund Romberg. Students sing ballads and ensembles from the shows covered within the course. The course culminates in a performance of a scenes program or musical review of the works studied in the class. (Every other year)

414. Performance Techniques for the Singing-Actor
Prerequisite: permission of instructor and primary voice teacher.
Credit—two hours
Study of performance disciplines that aid and develop the lyric theater performer. The material covered in the class is tailored to specific students’ needs within the voice and opera department. This would include (but not limited to) Specialized Diction Instruction, Advanced Acting Instruction, Dance Instruction, Specialized Repertoire Survey, Opera History Survey, and Audition Techniques. May not be repeated for credit. (Every other year)

415. Opera Repertoire
Prerequisite: permission of instructor and voice teacher.
Credit—one hour
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. Designed to musically prepare singers for OP 416 in the spring semester. May be repeated for credit. (Fall, offered concurrently with OP 405)

416. Advanced Opera Seminar: Performance Techniques
Prerequisites: two semesters of OP 209, 210; two semesters OP 211–214; and/or permission of instructor.
Credit—two hours
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.

ORGAN (ORG)

430. Secondary Organ
Credit—one and a half hours
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 two credits per semester.

460A. Primary Organ
Credit—four hours
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 five credits per semester.

PEDAGOGY (PED)

210. Harp Pedagogy I
Credit—one hour
Fundamentals of harp technique, including the exploration of methods and repertory for teaching harpists of all ages. (Required for undergraduate harp students in the junior year but open to other harp students.)

211. Harp Pedagogy II
Credit—one hour
Fundamentals of harp technique, including the exploration of methods and repertory for teaching harpists of all ages. (Required for undergraduate harp students in the junior year but open to other harp students.)

406. Graduate Jazz Pedagogy
Prerequisite: MM JCM major or permission of instructor.
Credit—two hours
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.
420. Pedagogy of Accompanying  
**Prerequisite:** permission of instructor.  
**Credit—two hours**

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. (Every 2–3 years)

421. Pedagogy of Accompanying  
**Prerequisites:** permission of instructor and PED 420.  
**Credit—two hours**

Required reading continues; observations continue; business aspects; possibility of some supervised teaching experience. (Every 2–3 years)

431. String Pedagogy and Literature I  
**Credit—two hours**

For graduate students in string performance who wish to teach in private studio settings. Topics covered vary but 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.

432. String Pedagogy and Literature II  
**Credit—two hours**

For graduate students in string performance who wish to teach in private studio settings. Topics covered vary but 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.

440. Survey of Child’s Musical Development  
**Credit—two hours**

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.

451. Renaissance Lute Literature and Pedagogy  
**Credit—two hours**

Literature and pedagogy for lute and other plucked instruments from the fourteenth through the sixteenth centuries. Works are performed from original sources in French, Italian, Neapolitan, and German tablature as well as mensural notation in all clefs. Major treatises of the period are studied, and the playing techniques and performance practices explored. (Alternate years)

452. Baroque Lute Literature and Pedagogy  
**Credit—two hours**

Literature and pedagogy for lute, archlute, theorbo, and baroque guitar in the seventeenth and eighteenth centuries. Works are 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 are studied, and the playing techniques and performance practices explored. (Alternate years)

461. Graduate Practical Piano Pedagogy I  
**Credit—two hours**

In addition to the coursework involved in 261–262, graduate students would be responsible for one of the following: (1) in-depth analysis of current piano pedagogy curricula in various music-school degree programs, (2) creation of a pedagogy syllabus for one-semester and two-semester sequences, (3) construction of a personal teaching philosophy, (4) thorough examination of websites devoted to piano pedagogy, (5) 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.

462. Graduate Practical Piano Pedagogy II  
**Credit—two hours**

In addition to the coursework involved in 261–262, graduate students would be responsible for one of the following: (1) in-depth analysis of current piano pedagogy curricula in various music-school degree programs, (2) creation of a pedagogy syllabus for one-semester and two-semester sequences, (3) construction of a personal teaching philosophy, (4) thorough examination of websites devoted to piano pedagogy, (5) 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.
471. Teaching Internship
Credit—two hours

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.

472. Teaching Certificate Internship

481. Principles of Vocal Pedagogy
Credit—two hours
Prerequisite: PED 281–282, Undergraduate Vocal Pedagogy or its equivalent.

Designed to advance the students’ 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.

482. Advanced Vocal Pedagogy
Credit—two hours
Prerequisite: PED 481 or its equivalent.

Advanced Vocal Pedagogy: seminar discussions of selected readings and practical application of the principles discussed in PED 481 through supervised teaching. Each member of the class is assigned two students, each of whom will be taught one hour per week. A diary is maintained recording the progress of the student, and a typed summary from this record is turned in at the end of the semester. Twice during the semester, PED 482 students teach their students during class time with a discussion to follow. In addition, students spend time in the studios of several voice teachers observing a lesson and then teaching the student observed a minimum of 30 minutes under the supervision of the studio teacher.

430. Secondary Percussion
Credit—one and a half hours
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 two credits per semester.

460A. Primary Percussion
Credit—four hours
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 five credits per semester.

430. Secondary Saxophone
Credit—one and a half hours
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 two credits per semester.

460A. Primary Saxophone
Credit—four hours
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 five credits per semester.
**SACRED MUSIC (SMU)**

**407 and 408. Perspectives in Sacred Music**  
*Credit—two hours*  
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 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.

**410. Schola Cantorum**  
*Prerequisite: permission of instructor Stephen Kennedy following audition.*  
*Credit—one hour*  
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 (October through April). Rehearsals are Sunday evenings from 7:30 to 8:45 (rehearsals begin at 7 p.m. on first Sundays of the month).

**471 and 472. Sacred Music Internship**  
*Credit—one hour*  
Sacred Music Internship: Students in the internship normally are 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, set individualized plans/goals of study for the internship. Students can expect to be observed at least twice per semester by the faculty mentors and to participate in regular colloquia on current issues in church music.

**TUBA (TBA)**

**430. Secondary Tuba**  
*Credit—one and a half hours*  
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 two credits per semester.

**460A. Primary Tuba**  
*Credit—four hours*  
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 five credits per semester.

**TROMBONE (TBN)**

**430. Secondary Alto Trombone**  
*Credit—one and a half hours*  
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 two credits per semester.

**460A. Primary Trombone**  
*Credit—four hours*  
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 five credits per semester.

**THEORY (TH)**

**400. Analytical Techniques**  
*Credit—three hours*  
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.

**401. Topics in Tonal Literature and Analysis**  
*Credit—three hours*  
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 varies from semester to semester. Topics include meter/rhythm, harmonic syntax, motivic structure, deeper-level linear structure, formal processes, and text/music relationships.

**402. Topics in Non-Tonal Music Literature and Analysis**  
*Credit—three hours*  
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 varies from semester to semester. Topics include
meter/rhythm, harmonic syntax, motivic structure, deeper-level linear structure, formal processes, and text/music relationships.

**402A. Theory and Analysis of Contemporary Music**

**404. Eighteenth-Century Keyboard Improvisation**

**411. Introduction to Theory and Analysis of Tonal Music**
*Prerequisite:* at least one upper-level undergraduate form and analysis course. Open to DMA, MM, MA, and qualified undergraduates by permission.
*Credit*—three hours

Introduction to the theories of Heinrich Schenker and their application to the analysis of tonal music. Intensive analytical work and selected readings.

**412. Acoustics**
*Prerequisite:* TH 202. Students who have received credit for TH 212 may not enroll in this course.
*Credit*—three hours

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.

**421. Pedagogy of Theory**
*Credit*—three hours

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.

**422. Pedagogy of Theory: Advanced**

**431. Seminar in Analysis and Performance**
*Prerequisite:* TH 400 or the equivalent.
*Credit*—three hours

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.

**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.
*Credit*—three hours

An introduction to computer programming and data mining for music research. Course topics 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.

**451. Modal Counterpoint**
*Credit*—three hours

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.

**452. Eighteenth-Century Counterpoint**
*Credit*—three hours

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 chorale preludes, binary dances, inventions, and fugues.

**460. Music and the Mind**
*(Same as TH 260)*
*Prerequisite:* TH 101 or MUR 110 or 111.
*Credit*—three hours

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.

**461 and 462. Aural Musicianship for Conductors**
*Credit*—one hour

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.

**471. Apprenticeship in Pedagogy**
*Credit*—one hour

A two-semester, student-mentor relationship in which students learn first-hand about the workings of the undergraduate curriculum and then design a project. In the first semester, students observe each of the undergraduate core courses and keep a journal that reflects self-awareness of pedagogical technique and materials. Students submit a written summary of each of the c. 30 observations at the end of the semester. In the second semester, students create, design, and craft an original project that focuses on some pedagogical aspect of the written or aural curricula. A teaching recital and a skills exam are also required as final projects for TH 472. Open only to MA in Theory Pedagogy majors.
472. Apprenticeship in Pedagogy  
Credit—two hours  
A two-semester, student-mentor relationship in which students learn first-hand about the workings of the undergraduate curriculum and then design a project. In the first semester, students observe each of the undergraduate core courses and keep a journal that reflects self-awareness of pedagogical technique and materials. Students submit a written summary of each of the c. 30 observations at the end of the semester. In the second semester, students create, design, and craft an original project that focuses on some pedagogical aspect of the written or aural curricula. A teaching recital and a skills exam are also required as final projects for TH 472. Open only to MA in Theory Pedagogy majors.

475. Intermediate Keyboard Skills  
Prerequisites: TH 202 or equivalent and Piano 104 proficiency; or permission of instructor.  
Credit—three hours  
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.

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 signature required.  
Credit—three hours  
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.

480. Advanced Harmony and Composition  
Credit—three hours  
A course that seeks to build a bridge between undergraduate theory studies and composition. The advanced material in Aldwell/Schacter, “Harmony and Voice-leading,” furnishes a point of departure for the course. Assignments begin with melody harmonization but lead quickly into sophisticated chorale settings. More advanced compositional projects include text setting in Lieder styles of the later nineteenth century or composition of short “character” pieces. Primarily for Theory majors. Available as an elective for other students with permission of the instructor.

481 and 482. Special Topics in Music Theory  
Credit—three hours  
A variety of analytical and theoretical topics of changing focus. Specific topics and instructors to be announced in advance. May be repeated for credit.

511. Introduction to Theory and Analysis of Tonal Music  
Credit—four hours  
Prerequisite: at least one upper-level undergraduate form and analysis course.  
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 PhD candidates; MA, MM, and DMA candidates should take TH 411.

513. Introduction to the Theory and Analysis of Twentieth-Century Music  
Credit—four hours  
Introduction to the theory and analysis of non-tonal music. Topics include cyclic, set, serial, contour, and transformational theories.

520. Proseminar in Analysis of Early Music  
Prerequisite: TH 401 or 511 or permission of instructor.  
Credit—four hours  
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.

521. Pedagogy of Theory  
Credit—four hours  
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.

522. Pedagogy of Theory: Advanced

523. History of Music Theory, Part I  
Credit—four hours

524. History of Music Theory, Part II  
Credit—four hours

531. Seminar in Analysis and Performance  
Credit—four hours  
Prerequisite: TH 400 or the equivalent.  
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.

481A. Website Construction
541. 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.  
Credit—four hours  
Computer Applications in Music Research: an introduction to computer programming and data mining for music research. Course topics 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.

542. Proseminar in Computer Applications  
Prerequisite: TH 441 or permission of instructor.  
Credit—four hours  
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.

560. Proseminar in Music Cognition  
Credit—four hours  
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.

581 and 582. Theory Seminar  
Prerequisite: permission of instructor.  
Credit—four hours  
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.

583. History of Theory  
Prerequisite: permission of instructor.  
Credit—four hours  
Part I of a two-semester survey of the history of music theory. The semester starts with the ancient Greeks and ends in the early eighteenth century, covering such topics as division of the pitch continuum, consonance and dissonance, rhythm/meter, mode/scale, counterpoint, and figured bass.

584. History of Theory II  
Credit—four hours  
Part II of a two-semester survey of the history of music theory. The semester starts with early eighteenth-century theory and ends in the early twentieth century, covering such topics as counterpoint, figured bass, functional harmony, tonal form, acoustics, Schenker, and chromaticism.

591. Theory Colloquium  
Credit—one hour  
Attendance and participation in department colloquia.

595. PhD Dissertation Project  
Credit—to be arranged

TRUMPET (TPT)

430. Secondary Trumpet  
Credit—one and a half hours  
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 two credits per semester.

460A. Primary Trumpet  
Credit—four hours  
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 five credits per semester.

VOICE (VCE)

430. Secondary Voice  
Credit—one and a half hours  
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 two credits per semester.

460A. Primary Voice  
Credit—four hours  
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 five credits per semester.
VIOLINCCELLO (VCL)

430. Secondary Cello  
*Credit—one and a half hours*  
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 two credits per semester.

460A. Primary Cello  
*Credit—four hours*  
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 five credits per semester.

VIOLA (VLA)

430. Secondary Viola  
*Credit—one and a half hours*  
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 two credits per semester.

460A. Primary Viola  
*Credit—four hours*  
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 five credits per semester.

VIOLIN (VLN)

430. Secondary Violin  
*Credit—one and a half hours*  
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 two credits per semester.

460A. Primary Violin  
*Credit—four hours*  
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 five credits per semester.
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Suzanne Y. Stevens, PhD (Indiana)  
Associate Professor of Neurobiology and Anatomy

Duje Tadin, PhD (Vanderbilt)  
Associate Professor of Brain and Cognitive Sciences and in the Center for Visual Science

Toru Takimoto, PhD (Hokkaido, Japan)  
Associate Professor of Microbiology and Immunology

Andy Yen-Tung Teng, DDS (Kaoshiung Medical College)  
Associate Professor of Dentistry and of Microbiology and Immunology

Sally W. Thurston, PhD (Harvard)  
Associate Professor of Biostatistics and Computational Biology and of Oncology

Edwin Van Wijngaarden, PhD (Carolina, Chapel Hill)  
Associate Professor of Public Health Sciences

Peter Vezzie, PhD (Minnesota)  
Associate Professor of Public Health Sciences

Dongwen Wang, PhD (Columbia)  
Associate Professor of Biostatistics and Computational Biology and of Medical Informatics

Brian Ward, PhD (Illinois)  
Associate Professor of Microbiology and Immunology

William H. Watson, PhD (Rosemead)  
Associate Professor of Psychiatry and of Neurology

Terry Wright, PhD (Rochester)  
Associate Professor of Pediatrics and of Microbiology and Immunology

Tongtong Wu, PhD (California, Los Angeles)  
Associate Professor of Biostatistics and Computational Biology

Chen Yan, PhD (University of Washington)  
Associate Professor of Medicine, Aab Cardiovascular Research Institute

Shuyuan Yeh, PhD (Wisconsin)  
Associate Professor of Urology and of Pathology

Fay Young, MD (Harvard)  
Associate Professor of Medicine, of Pediatrics, of Oncology, and of Microbiology and Immunology

Wei-Ping Zeng, PhD (SUNY, Buffalo)  
Research Associate Professor of Pathology and Laboratory Medicine

Jiyong Zhao, PhD (Iowa State)  
Associate Professor of Biomedical Genetics and of Biochemistry and Biophysics

Jenny Speice, PhD (Virginia Polytechnic)  
Associate Professor of Biostatistics and Computational Biology

Michael Zuscik, PhD (Rochester)  
Associate Professor of Orthopaedics

Jacqueline Abranches, PhD (Brazil)  
Assistant Professor of Microbiology and Immunology in the Center for Oral Biology

Amina Alio, PhD (South Florida)  
Assistant Professor of Public Health Sciences

Danielle Benoit, PhD (Colorado)  
Assistant Professor and of Chemical Engineering, and in the Center for Musculoskeletal Research
Shubing Cai, PhD (Rochester)  
Assistant Professor of Public Health Sciences

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

Ethan David Cohen, PhD (Pennsylvania)  
Assistant Professor of Medicine, Endocrine and Metabolism Unit, and Aab Cardiovascular Research Institute

Michael Elliott, PhD (Washington)  
Assistant Professor of Ophthalmology, of Biomedical Engineering, and in the Center for Visual Science

Susan H. Horwitz, PhD (Union Institute)  
Assistant Professor of Psychiatry

Jennifer Hunter, PhD (University of Waterloo, Canada)  
Assistant Professor of Biostatistics and Computational Biology

Hua He, PhD (Rochester)  
Assistant Professor of Biostatistics and Computational Biology

Joseph Christopher Holt, PhD (Tulane)  
Assistant Professor of Otolaryngology, of Neurobiology and Anatomy, and of Pharmacology and Physiology

Sina Ghaemmaghami, PhD (Duke)  
Assistant Professor of Biomedical Genetics

Angela Glading, PhD (Pittsburgh)  
Assistant Professor of Pharmacology and Physiology and of Biomedical Engineering

Benjamin Hayden, PhD (California, Berkeley)  
Assistant Professor of Computer Science

Hua He, PhD (Rochester)  
Assistant Professor of Biostatistics and Computational Biology

Joseph Christopher Holt, PhD (Tulane)  
Assistant Professor of Otolaryngology, of Neurobiology and Anatomy, and of Pharmacology and Physiology

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Jennifer Hunter, PhD (University of Waterloo, Canada)  
Assistant Professor of Ophthalmology, of Biomedical Engineering, and in the Center for Visual Science

Todd Jusko, PhD (Washington)  
Assistant Professor in Public Health Sciences

Amy Kiernan, PhD (Boston)  
Assistant Professor of Ophthalmology and Biomedical Genetics

David R. Kornack, PhD (Cornell)  
Assistant Professor of Neurobiology and Anatomy

Jill Lavigne, PhD (Rochester)  
Assistant Professor of Neurobiology and Anatomy

Coeli Lopes, PhD (Brazil)  
Assistant Professor of Medicine

Tanzi Love, PhD (Iowa)  
Assistant Professor of Biostatistics and Computational Biology

Helene McMurray, PhD (Rochester)  
Assistant Professor of Genetics

Hongyu Miao, PhD (Rochester)  
Assistant Professor of Biostatistics and Computational Biology

Brad Z. Mahon, PhD (Harvard)  
Assistant Professor of Brain and Cognitive Sciences, of Neurosurgery, and in the Center for Visual Science

Monica Mittal, PhD (Texas Tech)  
Assistant Professor of Public Health Services

Wendy J. Nilsen, PhD (Purdue)  
Assistant Professor of Psychiatry and of Obstetrics and Gynecology

Ellen L. Poleshuck, PhD (Kent State)  
Assistant Professor of Psychiatry and of Obstetrics and Gynecology

Christopher Prosche, PhD (LICR)  
Assistant Professor of Biomedical Genetics

Matthew Rand, PhD  
Assistant Professor of Environmental Medicine

Peter Salzman, PhD (Stanford)  
Assistant Professor of Biostatistics and Computational Biology

Andrew Samuelson, PhD (SUNY, Stony Brook)  
Assistant Professor of Biomedical Genetics

Michael T. Sellix, PhD (Florida State)  
Assistant Professor of Medicine, Endocrine and Metabolism Unit, and of Pharmacology and Physiology

Christopher Sepelaki, PhD (Wisconsin)  
Assistant Professor of Public Health Sciences

Eric M. Small, PhD (Texas, Austin)  
Assistant Professor of Medicine, Aab Cardiovascular Research Institute, and of Pharmacology and Physiology

Scott Smith, MD (North Carolina)  
Assistant Professor of Public Health Sciences

Yin Sun, PhD (California, Los Angeles)  
Research Assistant Professor of Biomedical Genetics

James Taccì, MD (Rochester)  
Assistant Professor of Public Health Sciences

Takahiro Takano, PhD (New York Medical College)  
Assistant Professor of Neurosurgery in the Center for Translational Neuromedicine and of Neurology

Gregory G. Tall, PhD (Boston)  
Assistant Professor of Pharmacology and Physiology

Patricia M. White, PhD (California)  
Assistant Professor of Neurobiology and Anatomy

Viktor Yarotsky, PhD (Ukraine-Bogomoletz Institute of Physiology)  
Research Assistant Professor of Pharmacology and Physiology

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**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 one 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 one of 11 training programs in the basic and health sciences including...
clinical investigation, dental sciences, health services research and policy, immunology, marriage and family therapy, medical humanities, microbiology and virology, medical informatics, medical statistics, microbiology, neurobiology and anatomy, and public health.

**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.

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**Biochemistry and Biophysics**

**Professors** †Bambara, †Bohmann, †Bren, †Culver, Dumont, †T. Foster, †Goldfarb, †Gorbunova, Hayes (Chair), †Land, Maines, Maquat, †McGrath, †B. Miller, †O’Keefe, Phizicky, †Puzas, †Rothberg, Simon, Smith, †Smrcka, †D. Turner, †Waugh, Wedekind, Yu, †Yule

**Associate Professors** †A. Berger, †X. Bi, †P. Brookes, †Bulger, †Butler, †Dickerson, Goldstein, Grayhack, Grossfeld, †Kammermeier, Kielkopf, †Krauss, Mathews, Munger, †E. Sia, †J. Zhao

**Assistant Professor** Ermolenko

**Professors Emeriti** Gunter, Hilf, Kimmich, Lawrence, Senior

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**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.

**Requirements**

**Core Courses** (required for all programs of study): IND 408 (Advanced Biochemistry); IND 409 (Cell Biology); IND 410 (Molecular Biology and Genetics); IND 501 (Ethics 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): BIO 402 (Molecular Biology); Bio 415 (Molecular Biology of Cell

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* In the School of Arts & Sciences; see announcement in this bulletin.
† Primary appointment in another department.
Advanced biochemistry lecture course intended for senior undergraduates 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)

**IND 409. Cell Biology**  
**Credit—four hours**  
This course is intended primarily for first-year graduate students with some previous coursework in cell biology. One-hour lectures include discussion of specific modern topics, including cell cycle and its breakdown during cancer and apoptosis; cytoskeleton; intracellular compartments and protein sorting; signal transduction and cell-cell communication; membrane structure and transport. In addition to the lectures, weekly interactive journal-club-style sessions explore the current cell biology literature. (Fall)

**IND 410. Molecular Biology and Genetics**  
**Credit—four hours**  
This course is designed primarily for graduate students. One-hour lectures cover modern topics of interest, including DNA replication; DNA repair and mutagenesis; regulation of RNA transcription in eukaryotes; RNA processing, and protein translation. Emphasis is placed on both biochemical and genetic approaches to the study of these problems. Special additional topics include genomics as an approach to regulation and mammalian genetic techniques of analysis. (Fall)

**BCH 412. Advanced Topics in Biological Macromolecules**  
**Prerequisite: IND 408 or an equivalent biochemistry course. Credit—five hours**  
An advanced biochemistry lecture course intended for senior undergraduates 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)
BCH 515. Critical Thinking in Research Science
Credit—one hour

Students present a history of the experimental work leading to their research project. The history includes a selection of published and unpublished work from their advisor's lab and other labs in the same field that provides a rationale for undertaking the project. Students conclude with a report of their own published and preliminary data. The focus throughout is on interpreting experimental data and engaging student interactions. (Fall and Spring)

BCH 517. Cellular and Molecular Sciences
Credit—one hour

This course promotes understanding of seminars given in the weekly Department of Biochemistry and Biophysics seminar series. Students attend at least 60 percent of the presentations in the Department of Biochemistry and Biophysics Invited Speaker Seminar Series during the semester. In addition, instructors and students select speakers (one-third of the speakers in the series), and read 2–3 publications (suggested by the speaker) in depth. Students then present these papers to the rest of the class, the 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, in which they ask questions related to the papers and to the topic of the seminar. (Fall and Spring)

BCH 570. Chromatin and Transcription in Higher Eukaryotes
Credit—two hours

A literature-based course meeting once per week (two hours/session) where students read and discuss recent papers on selected issues relating to the regulation of gene expression in higher eukaryotes. The purpose is to familiarize students with a variety of contemporary research fields and methodologies through student-led discussions of current publications in the field. Papers are chosen by the instructor and focus on transcription regulatory mechanisms related to transcription factors and coactivators, the role of histone posttranslational modifications and other aspects of chromatin structure. (Spring, odd years)

BCH 593. Special Topics in Biochemistry
Credit to be arranged

Directed studies in the field of biochemistry, supervised by a senior faculty member and organized to meet the needs of individuals or small groups of graduate students. May involve supervised readings, laboratory exercises, or organized discussions.

BCH 595. Research
Credit to be arranged

Research centers around the following problems: regulation of lipid metabolism, structure and function of cell membranes, cell surface glycoproteins, physical chemistry of hemoproteins, biological energetics, structure of ATPases, hormonal regulation of mammary tissue and mammary tumors, hormone receptors, regulation of protein biosynthesis, DNA synthesis and repair, molecular genetics, and human diseases.

BIOPHYSICS DEGREE PROGRAM

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 core courses include BPH 411 (Methods in Structural Biology), BPH 509 (Molecular Biophysics), IND 408 (Advanced Biochemistry), IND 409 (Cell Biology), IND 410 (Molecular Biology and Genetics) and BPH 571/572 (Biophysics Seminar). 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.

The curriculum consists of core course requirements, general seminar and distribution requirements, elective courses, and laboratory rotations. The core courses include Molecular Biophysics, Advanced Biochemistry, Cell Biology, Molecular Biology and Genetics, and Methods in Structural Biology. 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.

Core Courses (required for all programs of study): IND 408 (Advanced Biochemistry); IND 409 (Cell Biology); IND 410 (Molecular Biology and Genetics); IND 501 (Ethics and Professional Integrity in Research); BPH 411 (Methods in Structural Biology); BPH 509 (Molecular Biophysics); BCH 571/572 (Biophysics Seminar); BPH 595 (PhD Research).

Elective Courses (suggested but not limited to): BCH 412 (Advanced Topics in Biological Macromolecules); BCH 515 (Critical Thinking in Research Science); BCH 517 (Cellular and Molecular Sciences); BIO 402 (Molecular Biology); BME 442 (Microbiomechanics); BPH 513 (Advanced Topics in Molecular Diffraction and Scattering); BPH 592 (Special Topics in Biophysics—Math for Molecular Biophysics); CHM 414 (Biological Inorganic Chemistry); CHM 423 (NMR Spectroscopy); IND 443 (Eukaryotic Gene Regulation); IND 447 (Signal Transduction).

IND 408. Advanced Biochemistry
Prerequisite: a one-semester introductory course in biochemistry or equivalent.
Credit—five hours

This course is designed primarily for graduate students. Eighty-minute lectures cover topics in modern biochemistry including analysis of protein and domain structure by classical and modern methods, including mass spectrometry, NMR, X-ray crystallography, and other biophysical techniques; protein-ligand and protein-protein interactions; enzyme kinetics and catalytic mechanisms; and cellular energy production and utilization. In addition, workshops are held once a week, during which time selected papers from the literature are discussed. (Fall)

IND 409. Cell Biology
Credit—four hours

This course is intended primarily for first-year graduate students with some previous coursework in cell biology. One-hour lectures include discussion of specific modern topics, including cell cycle and its breakdown during cancer and apoptosis; cytoskeleton; intracellular compartments and protein sorting; signal transduction and cell-cell communication; membrane structure and transport. In addition to the lectures, weekly interactive journal-club-style sessions explore the current cell biology literature. (Fall)

IND 410. Molecular Biology and Genetics
Credit—four hours

This course is designed primarily for graduate students. One-hour lectures cover modern topics of interest, including DNA replication; DNA repair and mutagenesis; regulation of RNA transcription in eukaryotes; RNA processing; and protein translation. Emphasis is placed on both biochemical and genetic approaches to the study of these problems. Special additional topics include genomics as an approach to regulation and mammalian genetic techniques of analysis. (Fall)

BPH 411. Methods in Structural Biology
Prerequisites: calculus-based physics, BPH 403, 408, or permission of the course director.
Credit—five hours

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 nonspecialists to become conversant in the language and principles of the field, as well as to understand the strengths and limitations of various techniques. This course is a prerequisite to the literature-based course BPH 592, Advanced Topics in Biomolecular Diffraction and Scattering. Nonmajors should also consider BCH 412, Advanced Topics in Biological Macromolecules. (Spring, even years)

BPH 509. Molecular Biophysics
Prerequisite: calculus-based physics; permission of course coordinator.
Credit—five hours

This course is designed to show how physical concepts and techniques are used to explore and understand biological phenomena. A major portion of the term focuses on thermodynamics of biological molecules and system and includes an in-depth exploration of computational biology methods for studying thermodynamics. Students are expected to have had basic courses in physics, chemistry, and biology, with an in-depth background in at least one of these areas. Students not in the biophysics program should consult the course coordinator before registering. (Spring, odd years)

BPH 571/572. Biophysics Seminars
Credit—one hour each

A student seminar course is offered each semester and continuous registration is required of all graduate students in biophysics. Seminars are presented by PhD students and include topics relevant to the interests of the department.

BPH 592. Special Topics in Biophysics
Credit—to be arranged

Special topics courses are offered each year that examine different aspects of biophysics in considerable depth.
BPH 592. Special Topics in Biomolecular Diffraction and Scattering
Prerequisites: BPH 402/BPH 403 and either BCH 412 or BPH 411 (or permission of the instructors).
Credit—one hour
A current survey of the literature chosen by the course instructors that discusses macromolecular structure with an emphasis on protein/RNA taxonomy and folding, as well as the mathematical and physical principles of diffraction and scattering. Each student presents a paper to the group for discussion and analysis. The goal of this class is to help students make cogent connections between theory and practice in the field.

BPH 595. PhD Research
Credit to be arranged
The fields open for dissertation research are listed in the preceding general description for each degree program. Laboratory space and equipment are available in sufficient variety and depth to accommodate a large range of research interests.

Biostatistics and Computational Biology

Professors McDermott, Oakes, Strawderman (Chair), Tu, Wu
Associate Professors Almudevar, Beck, Feng, Hyrien, Johnson, Peterson, Qiu, Thurston, Wang, Wu
Assistant Professors He, Love, McCall, Miao, Salzman
Joint Appointments: Professors Chen, Mudholkar; Associate Professors Mathews, Sharma; Assistant Professor Thakar

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 Applied Linear Regression, Categorical Data Analysis, and Design of Clinical Trials, in addition to formal training in the use of statistical software. 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. 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, Clinical Trials; and 466, Categorical Data Analysis). Doctoral students serve as teaching assistants in these courses during the first two years of study. Training grants in Environmental Health Biostatistics (funded by the National Institute of Environmental Health Sciences [NIEHS]) and Biostatistics for HIV/AIDS (funded by the National Institute of Allergy and Infectious Diseases [NIAID]) help 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 background in college mathematics, including a year of advanced calculus or mathematical analysis (similar to MTH 265, 266), a course in linear and/or matrix algebra, and a year of probability and statistics (similar to STT 201, 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:

### Year 1: Fall
- BST 401. Probability Theory (4 credits)
- BST 411. Statistical Inference (4 credits)
- BST 464. Applied Linear Regression (4 credits)
- BST 487. Seminar in Statistical Literature (1 credit)
- BST 590. Supervised Teaching (2 credits)
- IND 501. Ethics and Professional Integrity in Research (1 credit)

### Year 1: Spring
- BST 413. Bayesian Inference (4 credits)
- BST 426. Linear Models (4 credits)
- BST 466. Categorical Data Analysis (4 credits)
- BST 487. Seminar in Statistical Literature (1 credit)
- BST 590. Supervised Teaching (1 credit)

### Year 1: Summer
- BST 477. Introduction to Statistical Software I (0 credits)
- BST 478. Introduction to Statistical Software II (0 credits)

### Year 2: Fall
- BST 402. Stochastic Processes (4 credits)
- BST 479. Generalized Linear Models (4 credits)
- BST 487. Seminar in Statistical Literature (1 credit)
- BST 590. Supervised Teaching (3 credits)
- Elective (4 credits)

### Year 2: Spring
- BST 412. Large Sample Theory (4 credits)
- BST 487. Seminar in Statistical Literature (1 credit)
- BST 513. Analysis of Longitudinal and Dependent Data (4 credits)
- BST 591. Reading Course at the PhD Level (3 credits)
- Elective (4 credits)

### Year 3+
Mostly reading and research, with some 400-level and 500-level courses

**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. Training in the use of statistical software (BST 477/478) is offered during the first six weeks of the summer as a computing rotation (no formal credit).
3. All PhD students are required to have at least four credits of supervised teaching and/or supervised consulting (BST 590, 592).
4. 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.
5. 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.

6. 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

- Frailty Models in Survival Analysis
- Causal Inference and Its Applications
- Advanced Topics in Object Data Analysis
- Time Series
- ROC Curve Analysis
- Smoothing Methods
- Statistical Inference under Order Restrictions
- The Bootstrap, the Jackknife, and Resampling Methods
- Advanced Bayesian Inference with an Emphasis on Computation
- Model Selection and Validation

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 484—Cost-Effectiveness Research).

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: (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, computer science, and/or biology, including mathematical analysis (advanced calculus) and linear algebra, a year of probability and statistics, and basic computer science and biology. There is no foreign language requirement. Computer expertise is developed in the program.

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 and in the material covered on the written examination (advanced part).

Coursework is concentrated in several areas—inférence, data analysis, bioinformatics, and computational biology. 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. At the same time, students in the BCB concentration are expected to take both web lab and dry (computational) lab rotations for the first two years until selecting one or two thesis advisors (ideally one computational/statistics advisor and one wet lab advisor). The balance of time is spent on reading and research. Students entering with advanced training in statistics, bioinformatics, and 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

- BST 401. Probability Theory (4 credits)
- BST 411. Statistical Inference (4 credits)
- BST 464. Applied Linear Regression (4 credits)
- BST 496. Wet/Dry Lab Rotation (1 credit)
- BST 590. Supervised Teaching (2 credits)
- IND 501. Ethics and Professional Integrity in Research (1 credit)

### Year 1: Spring

- BST 413. Bayesian Inference (4 credits)
- BST 426. Linear Models (4 credits)
- BST 432. Introduction to Bioinformatics (4 credits)
- BST 496. Wet/Dry Lab Rotation (1 credit)
- BST 590. Supervised Teaching (3 credits)

### Year 1: Summer

- BST 477. Introduction to Statistical Software I (0 credits)
- BST 478. Introduction to Statistical Software II (0 credits)

### Year 2: Fall

- BST 431. Introduction to Computational Systems Biology (4 credits)
- BST 479. Generalized Linear Models (4 credits)
- BST 496. Wet/Dry Lab Rotation (1 credit)
- BST 590. Supervised Teaching (3 credits)
- Elective (4 credits)
Year 2: Spring

BST 431. Introduction to Computational Biology (4 credits)
BST 496. Wet/Dry Lab Rotation (1 credit)
BST 513. Analysis of Longitudinal and Dependent Data (4 credits)
BST 591. Reading Course at the PhD Level (3 credits)
Elective (4 credits)

Year 3+
Mostly reading and research, with some 400-level and 500-level courses.

Notes
1. 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.
2. 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.

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 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 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 master’s 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 all the 400-level 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>
<thead>
<tr>
<th>Fall</th>
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<tbody>
<tr>
<td>BST 411. Statistical Inference (4 credits)</td>
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<tr>
<td>BST 421. Sampling Techniques (4 credits)</td>
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<tr>
<td>BST 464. Applied Linear Regression (4 credits)</td>
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<tr>
<th>Spring</th>
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<tr>
<td>BST 422. Design of Experiments (2 credits)</td>
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<tr>
<td>BST 441. Applied Multivariate Analysis (2 credits)</td>
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<tr>
<td>BST 465. Design of Clinical Trials (4 credits)</td>
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<tr>
<td>BST 466. Categorical Data Analysis (4 credits)</td>
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<table>
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<tr>
<th>Summer</th>
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<tr>
<td>BST 493. Internship/Applied Project (8 credits)</td>
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The following courses are offered; see also offerings in mathematics (including the program in statistics). Unless otherwise noted all courses carry four credit hours.

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.

402. Stochastic Processes
Prerequisite: BST 401.
Markov chains; birth-death processes; random walks; renewal theory; Poisson processes; Brownian motion; branching processes; martingales; with applications.
411. Statistical Inference
Prerequisites: STT 203 and MTH 265 or equivalent.
Probability distributions, transformations and sampling distributions; statistical models; estimation, hypothesis testing, and confidence intervals for parametric models; introduction to large-sample methods.

412. Large-Sample Theory and Methods
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.

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.

416. Applied Statistics
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.

421. Sampling Techniques
Prerequisite: STT 203 or STT 213.

422. Design of Experiments
Prerequisite: BST 416 or BST 464 or BST 476.
Credit—two hours
Basic designs and their principles; randomization; blocking; use of concomitant information.

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.

431. Introduction to Computational Biology
Prerequisites: Calculus, Differential Equations, and BST401.
Basics of statistical learning; nucleic acid sequence modeling; protein sequence modeling; molecule structure and visualization; data exploration by clustering; phylogenetic trees; cell pathways; network dynamics and topology analysis; modeling molecular events; biochemical and cell kinetics; compartmental analysis; population dynamics; basics of digital image processing; image feature extraction and pattern analysis; image modeling.

432. Introduction to Bioinformatics
Prerequisites: BST 401 and 411.
Application of statistical theory to the analysis of high throughput data; introduction to Bioconductor (gene expression structure, annotation and metadata, creating packages); 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; gene set analysis, ontologies, enrichment analysis; classification (feature selection, multivariate methods, machine learning, cross-validation); pathway and network models (relevance networks, probabilistic graphical models, Bayesian networks, Markov networks, Boolean networks).

433. Introduction to Computational Systems Biology
Prerequisites: Calculus, Differential Equations, BST 401 and 411.
Applications of modeling biological systems and processes; introduction to systems concepts and systems theory; mathematical representations of systems; linear ordinary differential equation (ODE) systems; nonlinear ODE systems; network motifs; network robustness; modeling of biochemical systems; gene regulatory network systems; multi-scale biological systems; systems biology experimental design; identification of biological systems using experimental data.

435. Bioinformatics Databases and Applications
Introduction to biological databases; sequence databases; structure databases; interaction databases; pathway databases; heterogeneity in databases; complexity of biological data; database design; database integration and information retrieval.

441. Applied Multivariate Analysis
Prerequisite: BST 426 or BST 476.
Credit—two hours
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.
450. Data Analysis
Prerequisites: BST 426 and BST 477 or BST 478.
Statistical analysis of data under nonstandard conditions; examination of adequacy of model assumptions; goodness-of-fit testing; transformations; robust inference.

451. Exploratory Data Analysis
Prerequisites: BST 416 or BST 476 and BST 478.
Graphical techniques to reveal structure in data; model fitting to describe structure; model checking; transformations; outliers and resistant fitting methods.

452. Design of Experiments
Prerequisites: BST 426 and BST 477 or BST 478.
Completely randomized designs; replication; covariate adjustment; randomized block designs; fixed vs. random effects; Latin and Graeco-Latin squares; confounding; nesting; factorial and fractional factorial designs; split-plot designs; incomplete block designs; response surfaces.

453. Introduction to Biostatistics
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.

454. Applied Linear Regression
Prerequisite: BST 463 or equivalent.
One-way 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.

455. Design of Clinical Trials
Prerequisite: BST 463 or equivalent.
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.

456. Categorical Data Analysis
Prerequisite: BST 464 or equivalent.
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.

476. Introduction to Linear Models
Prerequisite: STT 203 or STT 212 or BST 463.
Simple and multiple regression models; least-squares estimation; hypothesis testing; interval estimation; prediction; matrix formulation of the general linear model; polynomial regression; analysis of variance; analysis of covariance; methods for simultaneous inference; residual analysis and checks of model adequacy.

477. Introduction to Statistical Software I
Prerequisite: STT 212 or BST 463.
Restrictions: Open only to graduate students in offering department. Credit—none (Computing Rotation)
Introduction to a statistical software package. The software to be introduced may vary from year to year; a common choice is SAS. Generally offered during the first six weeks of the summer.

478. Introduction to Statistical Software II
Prerequisite: STT 212 or BST 463.
Restrictions: Open only to graduate students in offering department. Credit—one hour
Introduction to a statistical software package. The software to be introduced may vary from year to year; a common choice is R. Generally offered during the first six weeks of the summer.

479. Generalized Linear Models
Prerequisites: BST 411 and 426. Generalized linear models; computational techniques for model fitting; logistic and conditional logistic regression; loglinear models; models for nominal and ordinal categorical data; quasi-likelihood functions; model checking; introduction to semiparametric generalized linear models.

487. Seminar in Statistical Literature
Credit—one hour
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.

491. Reading Course at the Master’s Level
Credit—varies

493. Internship/Applied Project
Credit—eight hours
As required for completion of the MS 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.
495. Research at the Master’s Level
Credit—varies

496. Wet/Dry Lab Rotation
Students choose a bioinformatics experimental or computational lab for rotations.

511. Topics in Statistical Inference I
Prerequisite: Varies by topic.
Advanced topics in statistical inference and/or decision theory.

512. Topics in Statistical Inference II
Prerequisite: Varies by topic.
Advanced topics in statistical inference and/or decision theory.

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.

514. Survival Analysis
Prerequisites: BST 411 and BST 412 or BST 402.
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.

520. Current Topics in Bioinformatics
Prerequisites: BST 411 and 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; prognostic value of molecular signatures of cancer cells; common pitfalls in gene expression data analysis and a critical overview of the existing methods; methods for analysis of complex genetic traits and gene finding in genetic epidemiology; promising avenues for future statistical research in the field of bioinformatics.

521. Advanced Computing for Bioinformatics and Computational Biology
Prerequisite: Calculus.
Numerical optimization methods; numerical splines and interpolation; numerical algorithms for differential equations; Monte Carlo methods; parallel computing; selected application topics.

522. Big Data in Biomedical Research
Prerequisites: BST 411 and 435.
Introduction to big data concepts; identifying and locating relevant data: public databases and data repositories; data warehouses; managing and organizing big data: big data standardization, processing, and analysis; data mining and pattern recognition; big data integration and modeling.

523. Dynamic Modeling for Biological Processes
Prerequisite: BST 431.
Overview of dynamic models; useful linear algebra techniques; ordinary differential equations (ODE); partial differential equations (PDE); useful techniques for Markov chains; discrete-time dynamical systems; continuous-time dynamical systems; cellular dynamics and pathways of gene expression; ODE models for infectious diseases; spatial patterns and reaction-diffusion PDE models.

525. Introduction to Health Informatics
Prerequisite: 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.

526. High-Dimensional Bioinformatics Data Analysis and Inference
Prerequisites: BST 411 and 426.
High-dimensional linear regression models; linear methods for classification; basis expansions and regularization; kernel smoothing methods; model assessment and selection; model inference and averaging; additive models, trees, and related methods; boosting and additive trees; support vector machines and flexible discriminants; prototype methods and nearest-neighbors; unsupervised learning methods such as principal component analysis, cluster analysis, multidimensional scaling, and self-organizing maps.
527. Networks and Graphical Models in Genomic Applications
Prerequisites: BST 411, 432, and 433.
Systems biology: biological networks and their properties (connectivity, modularity, power law, clustering, network motifs); introduction to graph theory; measures of co-expression, correlation structures, and statistical methods; relevance networks; probabilistic graphical models: Bayesian networks, Markov Networks; boolean networks.

531. Nonparametric Inference
Prerequisite: BST 411 and 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).

536. Sequential Analysis
Prerequisite: BST 412.
The Wald sequential probability ratio test and generalizations; tests of composite hypotheses; nonparametric sequential procedures; sequential estimation and confidence intervals; Brownian-motion based sequential methods, with applications to clinical trials; group sequential methods; optimal stopping rules.

541. Multivariate Analysis
Prerequisites: BST 411 and BST 426.
Multivariate normal and Wishart distributions and associated distributions; estimation; invariance reduction; Hotelling’s $T^2$; 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.
Credit—varies
Advanced statistical methods for data analysis.

570. Topics in Biostatistics
Prerequisite: permission of instructor.
Credit—varies
Advanced biostatistical techniques.

582. Introduction to Statistical Consulting
Credit—varies
Formal instruction on developing and managing consulting relationships.
Comparative Medicine

Professor Wyatt
Associate Professor Moorman-White
Assistant Professor Bates
Residents Keene, Gordon

Graduate instruction is offered by the faculty of the Department of Comparative Medicine in areas related to the use of animals in medical research and teaching programs. Residency training in laboratory animal medicine is offered as a two-plus year program for veterinarians preparing for careers in this specialty.

395. Independent Study
Prerequisites: two years of undergraduate study or a graduate degree in biological sciences.
Credit—one to four hours
An independent study course involving a research project mentored by a department faculty member.

402. An Introduction to Laboratory Animal Biomethodology
Prerequisite: BS in biological sciences or professional degree (MD, DDS, or DVM) or permission of instructor.
Credit—one hour
The selection of the appropriate animal model, the principles of animal care and research techniques using animals is presented. Through the use of lectures, readings, and laboratories, the principles necessary to properly and humanely use laboratory animals are taught. This course is recommended for young scientists who will be using laboratory animals as models for the investigation of biological phenomena or as surrogates for man in their professional careers. (Spring)

Dentistry


The Eastman Department of Dentistry offers graduate dental residency programs in postdoctoral general dentistry (advanced education in general dentistry and general practice residency), oral and maxillofacial surgery, orthodontics, pediatric dentistry, periodontics, and prosthodontics. In addition, the department cooperates with other departments in the School of Medicine and Dentistry in offering programs leading to an MS or PhD degree in one of the basic medical sciences or an MS degree with a major in dental sciences as described under the Center for Oral Biology. Both the MS and PhD programs are open only to post-doctoral 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. In addition, selected residents in oral and maxillofacial surgery pursue an MD degree linked to their residency training.

* Part-time
Genetics

The graduate program in genetics offers doctoral training in the general areas of molecular and cellular biology with emphasis on biomedicine, genomics, and animal development. This is a very dynamic field with creative, multidisciplinary research addressed to problems of medical and biological relevance. The program of genetics combines faculty from multiple basic science and medical departments to provide a well-rounded training for a successful career in this area.

Training in the first year of the program comprises introductory graduate-level classes in molecular biology, biochemistry, and cell biology. These classes lay the foundation for advanced courses on specialized topics such as animal developmental genetics and various electives such as signal transduction or microbial genetics.

The genetics program emphasizes practical work in the research laboratory. Three laboratory rotations are a major component of the first year. During these rotations graduate students perform research projects in the laboratory of a faculty member affiliated with the program. The purpose of the rotation is to give the student experience in conducting independent research and to provide them with an in-depth view of the scope of research pursued by the program faculty. Typically, but not necessarily, graduate students choose one of the labs that have hosted the rotations for their PhD research.

Training in the second and the following years includes in-depth specialized elective courses and participation and presentation in departmental and laboratory seminar series, as well as journal clubs. Students are also expected to assist in the teaching of at least one course. In addition, students receive education on issues of science ethics. An external seminar series with high-caliber, invited speakers in the areas of genetics, genomics, development, and cancer biology provides students with the opportunity to gain up-to-date insight into 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.

REQUIRED COURSES

IND 408. Biochemistry
Prerequisite: a one-semester introductory course in biochemistry or equivalent.
Credit—five hours

This course is designed primarily for graduate students. Fifty-minute lectures cover selected topics in modern biochemistry, including analysis of protein and domain structure by classical and modern methods, including mass spectrometry, NMR, X-ray crystallography, and other biophysical techniques; protein-ligand and protein-protein interactions; enzyme kinetics and catalytic mechanisms; and, cellular energy production and utilization. In addition to lectures, workshops are held once a week, during which time selected papers from the literature are discussed. (Fall)

IND 409. Cell Biology

This course is intended primarily for first-year graduate students with some previous coursework in cell biology. One-hour lectures include discussion of specific modern topics including cell cycle and its breakdown during cancer and apoptosis; cytoskeleton; intracellular compartments and protein sorting; signal transduction and cell-cell communication; membrane structure and transport. In addition to the lectures, weekly interactive journal-club-style sessions explore the current cell biology literature. (Fall)

IND 410. Molecular Biology and Genetics

This course is designed primarily for graduate students. One-hour lectures cover modern topics of interest, including DNA replication; DNA repair and mutagenesis; regulation of eukaryotic RNA transcription, RNA processing and protein translation. Emphasis is placed on both biochemical and genetic approaches to the study of these problems. Special additional topics include genomics as an approach to regulation and mammalian genetic techniques of analysis. (Spring)

IND 501. Ethics in Research
Credit—none

This course is offered online and is required of all first-year graduate students and new postdoctoral fellows 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. (Fall)
GEN 503/504. Genetics Seminar
Credit—one hour

Seminar courses are given each semester, and continuous registration is required of all students in genetics. The genetics seminar is a forum for presentation of current research in genetics. Students in the genetics program are required to present their research in the seminar every 12–16 months starting at the end of year two. Seminars are held weekly.

GEN 507. Advanced Genetics and Genomics
This course offers in-depth discussions of theoretical concepts and experimental strategies in genetics and genomics. Lectures cover genetically tractable model organisms, including yeast, Drosophila, Caenorhabditis elegans (a nematode), mouse, and human and their analyses from gene to genome and systems level. Examples of the particular questions that can be addressed with advantage in each genetic model are presented, and the special genetic approaches feasible in these respective systems are emphasized. The course builds upon a strong prior background in Mendelian and molecular genetics. Topics 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. Topics incorporated recently include genome structure and evolution, small RNAs and mobile genetic elements, epigenetics and genomics, proteomics, and other studies at the whole genome level. (Fall)

GEN 595. PhD Research
PhD research may be undertaken in any of the participating departments under the direction of a faculty advisor.

SUGGESTED ELECTIVE COURSES

BCH 412. Advanced Topics in Biological Macromolecules
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, posttranslational modifications of proteins, ATPases, G protein and function, protein-protein interactions, proteases, and clotting.

BIO 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.

GEN 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)

GEN 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 program. (Alternate years)

IND 443. Eukaryotic Gene Regulation
This advanced course examines mechanisms of transcription initiation, eukaryotic chromosome structure and its modifications, mechanisms of chromatin-mediated regulation of gene expression, as well as epigenetics and functional genomics. Lectures and readings draw heavily on primary literature both classic and most recent. IND 443 and BIO 443 students are required to give a 30-minute presentation on a selected topic.

IND 447. Signal Transduction
Cellular signal transduction is a widely studied topic in the biomedical sciences. Cells have multiple-signal transduction mechanisms for sensing their chemical environment and converting the external signals into coordinated physiological responses. The course covers a spectrum of topics, including basic principles and mechanisms in cell signaling, contemporary experimental approaches to understanding signaling processes, and the role of signal transduction in normal and pathophysiology.

421. Microbial Genetics
Prerequisite: MBI 220.
Graduate students register for MBI 521 Seminar
Prerequisites: MBI 220 (or similar course) or BIO 198 (or similar course)
Credit—four hours undergraduate, three hours graduate

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.

473. Immunology
Prerequisites: BIO 121; BIO 150 or equivalent. BIO 202 strongly recommended.
Credit—four hours undergraduate, three hours graduate
Innate and adaptive immunity; structure and genetics of immunoglobulins and T cell receptors; lymphocyte development, immune regulation, immunological diseases, tumor immunity. (Fall)

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
Prerequisite: a one-semester introductory course in biochemistry or equivalent.
Credit—five hours
Designed primarily for graduate students. Eighty-minute lectures cover topics in modern biochemistry including analysis of protein and domain structure by classical and modern methods, including mass spectrometry, NMR, X-ray crystallography, and other biophysical techniques; protein-ligand and protein-protein interactions; enzyme kinetics and catalytic mechanisms; and cellular energy production and utilization. In addition, workshops are held once a week, during which time selected papers from the literature are discussed. (Fall)

409. Cell Biology
Credit—four hours
A graduate-level survey course in cell biology. Some previous exposure to cell biology is a prerequisite. As an advanced-level course, lectures focus on original experiments, critical thinking, and reading of the primary literature, rather than on rote memorization of facts and details. Students who have had little or no previous exposure to this material should take an undergraduate-level cell biology class (BIO 210) before enrolling in IND 409. (Fall)

410. Molecular Biology and Genetics
Credit—four hours
This course is designed primarily for graduate students. One-hour lectures cover modern topics of interest, including DNA replication; DNA repair and mutagenesis; regulation of RNA transcription in eukaryotes; RNA processing; and protein translation. Emphasis is placed on both biochemical and genetic approaches to the study of these problems. Special additional topics include genomics as an approach to regulation and mammalian genetic techniques of analysis. (Spring)

412. Graduate Experience in Science Education
Credit—three hours
This course introduces graduate students interested in pursuing academic career tracks to some fundamental understandings behind the theories, principals, and concepts of science education. Students learn practical teaching and communication skills to
help them relate science content to and increase their confidence in their teaching abilities. The knowledge and skills in lesson and course design, classroom instructional strategies, and differentiated assessment practices are useful to graduate students as they continue in their growth as educators throughout their careers.

**443. Eukaryotic Gene Regulation**
Prerequisites: introductory courses in genetics, biochemistry, and molecular biology are strongly recommended.

This course systematically examines the organization of the eukaryotic genome and its role in the regulation of gene expression. Topics discussed include structure of chromosomes, mechanisms of gene activation and transcription, epigenetic gene regulation, regulatory networks, and functional genomics. Lectures and readings draw heavily on current and classic primary literature. (Spring)

**447. Signal Transduction**
Prerequisite: IND 408 and 409
Credit—four hours

Cellular signal transduction is one of the most widely studied topics in the biomedical sciences. It has become clear that cells have multiple mechanisms for sensing the environment and converting the external signals into intracellular responses that are important for regulation of human physiology. The goal of this course is for students to learn modern concepts in signal transduction. The lectures cover a spectrum of topics ranging from basic principles and mechanisms of signal transduction to contemporary techniques for doing research in this area. (Spring)

**501. Ethics and Professional Integrity in Research**
Credit—one hour

This course is required of all graduate students in the biomedical sciences and clinical disciplines in the School of Medicine and Dentistry. The course features eight 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, and publication/copyright. The course is offered in a lecture/case study and small discussion group format. (Fall)

**506. Ethics and Professional Integrity in Research—Postdoctoral**
Credit—none

This course is required of all postdoctoral appointees in the basic science and clinical disciplines in the School of Medicine and Dentistry who are supported by federal training grants. The course features eight 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, and publication/copyright. The course is offered in a lecture and small discussion group format. (Fall)

### Marriage and Family Therapy

Professor McDaniel
Associate Professors Gawinski, Pisani, Podgorski (Codirector), Speice (Codirector), Watson
Assistant Professor Rosenberg
Senior Instructors, Giuffre, Swanger-Gagné
Clinical Associate Professor Driscoll
Clinical Assistant Professors Seaburn, Yeager
Clinical Senior Instructors Briody, Chiang
Professor Emeritus le Roux

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, and cultural transition, postgraduate training has been provided since 1981. The program trains professionals from multiple disciplines, including medicine, nursing, social work, psychology, clergy, and education.

Coursework provides a broad-based, integrative, biopsychosocial approach to clinical practice. The program is committed to a systems and relational understanding of human functioning. The goals of the MS in marriage and family therapy are to (1) provide comprehensive training in marriage and family therapy skills; (2) teach the major systems approaches and theories and how these theories relate to psychopathology and are integrated across the lifespan, gender, sexuality, race, and culture; (3) prepare culturally aware marriage and family therapists; and (4) train students who are well versed in a scientist practitioner model. 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: Family Therapy Services (Strong Behavioral Health), a community hospital, primary care health center, program for the seriously and persistently mentally ill, and community mental health centers.

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).
THEORETICAL FOUNDATIONS

**PSI 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 541) and Human Development across the Family Life Cycle (PSI 545) courses.

**PSI 560. Narrative and Integrative Approaches 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.

CLINICAL PRACTICE

**PSI 492. Medical Family Therapy Intensive**
This course is a weeklong intensive class designed to introduce students to the foundations of Medical Family Therapy through didactic presentations, small group learning, and skills development. Students take part in 12 hours of small group learning, focusing on family of origin experiences with illness and health care, as well as case and systems consultation. Also included are 15 hours of didactic presentations by faculty of the Intensive and the Departments of Psychiatry and Family Medicine. Presentations are focused on medical family therapy, models of collaboration, and specific illnesses and their effect on families. Students also engage in three hours of Skills Workshops that employ simulated family role-plays to focus on executive and professional skills development.

**PSI 541. Foundations of Clinical Practice in Family Therapy**
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.

**PSI 542. Clinical Assessment in 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 and practice.

**PSI 543. Psychopathology and Systems**
This course reviews the basic issues in understanding major psychopathology with an emphasis on DSM-5 and ICD-10. A secondary focus is on applying the concepts from the fields of abnormal psychology and psychopathology to the clinical situation, with particular stress on diagnostic interview in family therapy. Students learn traditional diagnostics and psychopathology within a systems framework.

**PSI 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.

**PSI 566. Couples Therapy**
This course is an introduction to couples therapy. The major emphasis of the course is the integration of self, theory, and practice. The course reviews relevant theories for conceptualizing relationships, relationship satisfaction, conflict in relationships, and the principal approaches to couples therapy. Assessment, diagnostic formulations, techniques, 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.

**PSI 574. Child-focused Family Therapy**
This course focuses on learning about child development, including an overview of both normal and abnormal development. Students also learn how to work clinically with children in the context of family therapy.

**PSI 587/588. Clinical Practicum**
Clinical Practicum provides students with the opportunity to practice independently in one or two of several psychiatric and health care settings in the community. Each student meets weekly with an AAMFT Approved Supervisor or Supervisor in Training (SIT) to review DVDs and further develop conceptual and clinical skills. (Expectation: 500 supervised clinical contact hours.)

INDIVIDUAL DEVELOPMENT AND FAMILY RELATIONS

**PSI 545. Human Development Across the Family Life Cycle**
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.
PSI 570. Gender, Human Sexuality, and Culture
This course develops a historical perspective on the issues related to gender, race, and culture in family therapy. Students learn the role that gender, race, ethnicity, sexual preference, and cultural beliefs play in family life and clinical practice.

PROFESSIONAL IDENTITY AND ETHICS

PSI 548. Family Therapy Ethics and Professional Practice
This course focuses on the AAMFT Ethical Code expectations dealing with such issues as confidentiality, dual relationships, individual and family welfare, etc. Relevant legal guidelines and professional practice standards are also reviewed. Students also address personal issues related to the impact of values, beliefs, and culture on the practice of family therapy.

PSI 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 these various professional groups, all of which affect clinical practice. This class is helpful for any professional who regularly interacts with families in their professional career and is likely to encounter life changing events for the family, including, but not limited to, marriage, divorce, birth of a child, death of a loved one.

RESEARCH

PSI 572. Family Therapy Research
This course in 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 review evidence-based family therapy techniques and learn how to critically evaluate effectiveness of treatment.

PSI 584. Master’s Project
Students must 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 should be based on an approved Masters Project proposal 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 (i.e., a comparison of partner violence in families with and without children in the home); or an essay on aspects of collaboration with faculty research (i.e., designing instruments, analyzing data sets, developing research protocols, program development).

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 usual minimal requirements are general biology, general chemistry, analytical chemistry, and organic chemistry. Applicants seeking the PhD degree are expected, in addition, to have a year of mathematics and physics. Physical chemistry and biochemistry are desirable. 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 and immunology. All programs will involve a basic grounding in biochemistry, and will include an important emphasis in biology at the molecular and cellular levels. The department offers several tracks leading to a PhD in microbiology and immunology. Particulars about the PhD programs in the various tracks are available from the departmental office on request.

The MS degree (Plan A) is intended for those whose career goals are in research. The course program includes microbiology, biochemistry, and additional courses appropriate to the individual’s area of research plus thesis research. The thesis, while not expected to be as extensive as a PhD thesis, must be based on research of significant scientific value. In most cases the candidate must spend approximately two years to complete the program.

Persons 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 core requirement for the PhD. In addition, a written essay consisting of a critical review of some area of microbiological literature plus a final oral examination based on the essay and on the relevant material covered in courses are required.

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

* Primary appointment in another department
prepare graduates for careers in biomedical research by allowing them to earn both BS and MS degrees in five years. Pursuit of the MS in immunology, microbiology, and virology affords the opportunity for selected students to receive intensive, advanced training in the allied fields of immunology, microbiology, virology, and biotechnology, with a focus on hands-on research and “real world” skills including critical scientific thinking, scientific communication, group dynamics, problem solving, and data analysis, and instruction in drug discovery. The goals are to reflect the interconnected and complexity of biomedical sciences as well as the increasing requirement for teamwork in problem solving in the workforce.

402. Writing in Microbiology
This course provides a hands-on introduction to scientific writing geared towards biologists. The curriculum encompasses a wide range of writing applications including peer-reviewed scientific manuscripts, scientific reviews, grant proposals, and scientific articles for general audiences. Sections on how to organize data for proposals and publication are included; there is also a section on scientific presentations and PowerPoint. This course can satisfy the upper-level writing requirement.

403. Drug Discovery
Credit—two hours
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.

404. Introduction to Emerging Pathogens
Credit—three hours
The past several decades have been marked by 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, with a particular focus on the evolution of zoonotic infectious agents and their adaptation to new hosts. The role of deforestation, globalization, and climate change in the development of emergent pathogens is also considered, as well as the potential risks posed from future technological advancements, such as synthetic biology and bioterrorism.

414. Mechanisms of Microbial Pathogenesis
Prerequisites: MBI 220 and 221.
Graduate students register for MBI 514 seminar
Credit—four hours undergraduate, three hours graduate
The course provides an examination of host-pathogen interactions and details the mechanisms microbes use to evade the immune response and cause disease. The emphasis is on a molecular level understanding of microbial pathogenesis, including colonization, invasion, antigen variation, toxin production, and mode of virulence factor action. In addition, how host defense mechanisms interact with pathogenic microbes is examined.
(Alternate years)

421. Microbial Genetics
Prerequisites: MBI 220 (or similar course) or BIO 198 (or similar course)
Graduate students register for MBI 521 seminar
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.

431. Microbiology Physiology
Prerequisite: a course in biochemistry.
Doctoral students register for MBI 531 seminar
Credit—four hours undergraduate, three hours graduate
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. (Fall, alternate years)

456. General Virology
Credit—five hours undergraduate, four hours graduate
Provides an introduction to animal virology, with emphasis on human diseases. Topics covered include the following: general properties of viruses, virus structure, biochemistry of virus replication, virus-host cell interactions, pathogenesis, HIV/AIDS, vaccines, antivirals, and viral vectors and gene therapy. Three exams.

473. Immunology
Prerequisites: BIO 121; BIO 150 or equivalent. BIO 202 strongly recommended.
Credit—four hours undergraduate, three hours graduate
Innate and adaptive immunity; structure and genetics of immunoglobulins and T cell receptors; lymphocyte development, immune regulation, immunological diseases, tumor immunity. (Fall)
421. Microbial Genetics
Prerequisites: MBI 220 (or similar course) or BIO 198 (or similar course)
Graduate students register for MBI 521 seminar
Credit—four hours undergraduate, three hours graduate

This course provides an in-depth examination of representative genetic systems in bacteria and viral 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.

431. Microbiology Physiology
Prerequisite: a course in biochemistry.
Doctoral students register for MBI 531 seminar
Credit—four hours undergraduate, three hours graduate

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. (Fall, alternate years)

456. General Virology
Credit—five hours undergraduate, four hours graduate

Provides an introduction to animal virology, with emphasis on human diseases. Topics covered include the following: general properties of viruses, virus structure, biochemistry of virus replication, virus-host cell interactions, pathogenesis, HIV/AIDS, vaccines, antivirals, and viral vectors and gene therapy. Three exams.

473. Immunology
Prerequisites: BIO 121; BIO 150 or equivalent. BIO 202 strongly recommended.
Credit—four hours undergraduate, three hours graduate

Innate and adaptive immunity, structure and genetics of immunoglobulins and T cell receptors, lymphocyte development, immune regulation, immunological diseases, tumor immunity. (Fall)

491. Reading Course at the Master’s Level
Credit—to be arranged

492. Microbiome
Credit—four hours undergraduate, three hours graduate

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 introductory 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 role of deforestation, globalization, and climate change in the development of emergent pathogens is also considered, as well as the potential risks posed from current and future technological advancements, such as research into the design of biological weapons and the construction of synthetic life forms.

493. Master’s Essay
Credit—to be arranged

495. Master’s Research
Credit—to be arranged

501. Microbiology and Immunology Student Seminar Series
Credit—one hour

A program of seminars held once a week and conducted by graduate students is presented each semester. Continuous registration is required of all PhD 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 nonspecialized scientific audience. Students starting from their second year are required to present three times. The first two presentations 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 last presentation should be formal, 45 minutes long, “research in progress” seminars allowing 10–15 minutes for questions. Presenters are expected to answer questions from other students and from faculty in the audience. Confidential evaluation provides feedback to presenters.

507. Graduate Microbiology Laboratory Rotations
Credit—eight hours

Consists of a series of laboratory experiences, each of approximately eight weeks, in laboratories of several faculty members. Usually, PhD students are expected to enroll for three rotations (eight hours of credit).

514. Pathogenic Mechanism Seminar
Credit—one hour

Seminar offered concurrently with MBI 414. Required for PhD students. (Spring, alternate years)

515. Advanced Immunology

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. Through 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.

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.
Credit—one hour

This course is designed to provide participating 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, the course 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.

519. Experimental Design and Analysis
Credit—one hour

Required for all entering MBI students. The goals of this course are to (1) facilitate transition of first year PhD students to independent thinkers and researchers through interactive discussion of rotation projects: conceptual framework of project, questions addressed goals, experimental approaches and data analyses; (2) provide a collegial venue for first-year students to interact and become familiar with each other’s background, interests, and expertise; (3) help students become accustomed to seeking advice from peers and faculty on any and all aspects of scientific research; (4) provide feedback on logic and organization research rotations and identify needed areas of background reading for rotation project; and (5) provide a framework for rotation reports: format, sections, faculty expectations, and discussion of the rationale for the students to write these reports. At the beginning of the course, 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. As the class progresses, students present their rotation project including such issues as question(s) addressed in the project, rationale for the experimental approach taken, potential results and path the project may take, and finally, key literature that is relevant to their rotation project. In the final segment of the class, students seek and gain advice on preparing their research rotation reports and options for preparing and submitting proposals for funding. Participation of all students in the discussion of research projects and sharing of ideas throughout the class is expected.

521. Topics in Microbial Genetics
Credit—one hour

This is the concurrent seminar required for graduate students registering for MBI 421. (Spring, alternate years)

531. Microbial Physiology Seminar
Credit—one hour

This 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.

540. Advanced Topics in Immunology
Prerequisite: permission of instructor.
Credit—two hours

An in-depth inquiry (via student seminars, class discussions, original literature) into one contemporary facet or subfield of immunology. Selection of the topic for a given seminar is at the discretion of the students and the immunology faculty member who is responsible for the course that semester. Previous topics include T-cell Recognition in Tumor Immunity and Autoimmunity, Behavioral Regulation of Immunity, and The Genetics of the Mouse and Its Application in Immunology. (Spring)

570. Molecular Biology Seminar
Credit—one hour

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 and participate in discussion of the presented material.

573. Immunology Seminar
Credit—two hours

This discussion course covers a variety of topics that provide an overview of immunology with an emphasis on critical reading of original journal articles. Two to four papers are read each week with oral presentation and discussion by the students. Weekly oral presentation exams.

580. Immunology Journal Club and Research-in-Progress Seminar
Prerequisite: MBI 473.

Consists of the Immunology Journal Club (meets one 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.

581. Oral Microbiology
Credit—two hours

The course is focused on infectious diseases that occur in the human mouth. Dental caries, periodontal disease, and 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 are discussed. There is no textbook required for the course, but there are handouts and assigned reading from the literature for each session. (Fall, alternate years).

582–589. Specialty Seminars
Prerequisite: permission of instructor.
Credit—to be arranged

In any semester, various faculty members may offer seminar courses related to the area of their research interests. Announcements are made on the department bulletin board.

588. Virology Research Seminar
Credit—one hour

This course provides a forum for discussion of ongoing work in virology research laboratories at the University of Rochester. Topics include vaccine research, drug development and testing, gene therapy, and basic virology.

589. Advanced Topics in Virology
Credit—one hour

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.

593/594. Special Topics in Microbiology
Credit to be arranged

Directed studies in the field of microbiology, supervised by a senior faculty member and organized to meet the needs of individuals or small groups of graduate students.

595. PhD Research
Credit to be arranged

Research may be undertaken in virology, general medical microbiology, animal parasitology, immunology, genetics, physiology, bacterial cytology, and cellular immunology.

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**Neurobiology and Anatomy**


Assistant Professors *Crane, *Holt, Kornack, White

Research Associate Professors *J. Walton, *Wood

Research Assistant Professors Allen, Davidson, Rittenhouse, M. Walton

Professors Emeritus DelCerro

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 Neurobiology and Anatomy 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. This environment has recently expanded with an influx of new faculty, accompanied by a new diversity of interests and talents that has catalyzed a variety of novel educational and research opportunities and plans. Our website provides an evolving guide to our community and its programs (www.urmc.rochester.edu/smd/nanat).

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.

* Primary appointment in another department
biomedical engineering, and others. Interconnections between different levels of clinical education and graduate education are also strong. In addition to committed involvement in the MD/PhD program, we offer an Academic Honors Program in Medical Neurobiology (MD/MS), which adds an additional year of study, research, and teaching experience to the medical curriculum, culminating in an MS degree in neurobiology and anatomy along with the MD degree upon graduation.

The PhD program 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. 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.

The Neuroscience Graduate Program provides a comprehensive, research-intensive training experience for students seeking a PhD degree in the study of the nervous system. The first-year curriculum provides students with a thorough understanding of the fundamental concepts that underlie contemporary neuroscience, 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. At the end of the first year, students choose a PhD degree track (neuroscience or neurobiology and anatomy) and thesis advisor. To those choosing the neuroscience 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.

405. Hearing and Balance: Structure, Function, and Disease
Credit—three hours
This course is designed as a survey course to 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 also are examined. The course is presented in a lecture format, supplemented by handouts, visual media, and Internet/Web–based links. Class discussion is a key objective in this course. (Fall)

491. MS Reading
495. MS Research

411. Applied Cell and Molecular Biology
(Same as BME 411 and ANA 411)
Credit—three hours
The focus on this course is a practical understanding of gene expression, from DNA replication and RNA transcription and processing to protein translation and trafficking. This knowledge provides students with a foundation for understanding how cells function, both alone and in clusters that form tissues and organs. The coursework also provides students with a knowledge base to evaluate modern molecular biological techniques and their application to neuroscience. (Fall)

512. Cellular Neuroscience
(Same as ANA 512 and NSC 512)
Credit—five hours
Cellular and molecular mechanisms in the nervous system are discussed in detail. Among the topics covered are overview of cellular components and molecular approaches, voltage and transmitter gated ionic channels, second messenger modulation of ionic channels, biochemistry of synaptic transmission, inhibitory and excitatory amino acids, neuronal and glial cell lineage and growth factors, axonal path-finding, and experience-dependent plasticity. Sessions include lectures, discussions, and presentations of papers from the literature. (Fall)

513. Neuroinflammation
Prerequisite: NSC 512 and MBI 473/573 (Immunology) are recommended.

Inflammation contributes to secondary injury following brain trauma or stroke and is often a direct cause of neuropathology in the nervous system. And yet, neuroinflammation may also be critical for regeneration and repair. This course examines the role of inflammation in the central nervous system and highlights common mechanisms of response to a variety of neural insults, including autoimmunity, trauma, neurotoxicology, and neurodegeneration. Further topics include the roles glia, the acquired immune system, and the innate immune system play in response to neural insults in the unique “immune-privileged” environment of the CNS. (Spring, even years)

517. Advanced Topics in Sensory Systems
Prerequisites: ANA/NSC 512 or equivalent and ANA 531 or equivalent recommended.
Credit—three hours
This modular course focuses on how sights, tastes, sounds, and other sensory modalities are converted into electrical signals in a form that can be interpreted by the nervous system of invertebrates and mammals. Major discoveries that have shown how
sensory signals are detected by specialized receptors and organs are discussed. Each module focuses on transductions—the ion channels, G proteins, enzymes, and second messengers—that produce the responses of sensory cells and ultimately afferent discharge. (Spring)

518. Introduction to Neuroengineering
Prerequisite: ANA/NSC 531 or BME 260.
This course covers quantitative and computational aspects of neuroscience research. The course begins with a brief review of Hodgkin-Huxley channel dynamics and extends to advanced topics including cable equations, neural circuits, control systems, and neural models of behavior. There is an emphasis on simulation and modeling of both single neurons and neural networks and systems. (Fall)

521. Graduate Journal Club
Credit—one hour
Provides graduate students with experience in formulating and presenting in a small group setting based upon selections from an area of interest in the scientific literature. Skills involved in literature search, critical thinking, and guiding discussion are honed in a choice of approved journal club venues. (Fall and Spring)

522. Graduate Seminar
(Same as ANA 522, NSC 503)
Credit—one hour
This course provides a forum for developing and refining their oral presentation skills and for getting feedback on their research. Students deliver an annual seminar on their thesis research. Following each presentation, audience members complete an evaluation to provide the presenters with feedback on various aspects of their presentation. (Fall and Spring)

525. Mind, Brain, and Behavior
Credit—eight hours
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 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. (Weekday mornings, mid-August–mid-October)

526. Human Structure and Function
Credit—16 hours
This 14-week course provides a rare opportunity to join the medical school curriculum in learning the essential concepts and mechanisms underlying human biology from an integrated perspective, including both basic and clinical applications. Didactic lectures are matched with problem-based learning sessions, problem-solving conferences, and laboratory exercises that introduce students to the systematic study of human structure and function. This integrated course encompasses the disciplines of anatomy, embryology, histology, and physiology. The course includes comprehensive laboratory sessions in gross anatomy and histology, and the qualitative and quantitative aspects of human physiology, including fundamental principles and clinical relevance. Students of the nervous system come to appreciate firsthand the intricacies and ubiquity of the brain’s structural and functional interactions with the various systems of the body, as well as their evolutionary and developmental attributes. The course provides an introductory foundation for students interested in understanding and teaching these disciplines in undergraduate, graduate, allied health, and medical school settings. (Mid-September–late December)

531. Integrative and Systems Neuroscience
(Same as ANA/NSC 531, BCS 541)
Prerequisites: NSC 511, 512, 201, BCS 240, 507 or equivalent introductory neuroscience course.
Credit—six hours
This course provides a critical overview of current knowledge of systems neuroscience. The topics include an overview of approaches and techniques, a comprehensive account of functional connectivity, transmitters, neurophysiology, and behavioral measures of sensory and motor systems, the basal ganglia, the limbic and hypothalamic systems, as well as memory, attention, and neurobiology of language. In addition, a number of classes deal with neurobiology of disease. (Spring)

581. Teaching Tutorial in Human Structure and Function
Credit—three hours
This course provides an opportunity for students to acquire and develop skills in teaching human gross anatomy and histology. Students may opt for teaching one or both of these disciplines with credits arranged accordingly. For each discipline taught, students are expected to attend and assist in all laboratories as well as attend relevant lectures. Students also provide instruction and presentations to lab groups and assist in preparing and setting up examinations. Although designed primarily for advanced graduate students in neurobiology and anatomy, other graduate students may elect this course if they meet prerequisites. (Fall)

583. Teaching Tutorial in Neurobiology
Credit—three hours
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 Neurobiology
and Anatomy, other graduates may elect this experience with permission of the instructor. (Fall)

590. Lab Rotations in Neuroscience
Credit—variable
Laboratory rotations are intended to familiarize students with a technique, to gain an appreciation of different scientific approaches to a problem, and to gain exposure to an area of research that eventually leads to a focused area of investigation. Consultation with the advisory committee is required to plan rotation. (Fall, Spring, Summer)

591. PhD Readings

592. Neuroscience Journal Club
Credit—one hour
A seminar/reading course on current topics in neuroscience research for year-one students. The objective is to gain experience discussing and critically evaluating primary research articles covering a broad range of topics in neuroscience. (Fall, Spring)

593. Special Topics in Anatomy
Prerequisite: ANA/NSC 512.
Credit—variable
Directed studies of advanced topics in neurobiology, supervised by a faculty member and organized to fit special needs of individual graduate students.

595. PhD Research
Opportunity is afforded for qualified students to undertake research under the direction of members of the staff.

Neuroscience

Professors 1Aslin, 2Bidlack, 13Carney, 3Cory-Slechta, 1DeAngelis, 1Dewhurst, 2Dirksen, 1Duffy, 1Freeman, 1Gan, 6Gelbard, 1Goldman, 2Haber, 1Huxlin, 1Johnson-Voll, 1Knill, 1Meringan, 1Mink, 11Moynihan, 10Nedergaard, 7Newlands, 13Noble, 1E. Nordeen, 1K. Nordeen, 1O’Banion, 1Paige, 1Pasternak, 1Schieber, 1N. Schor, 1Shrager, 1Tank, 7Thorton, 1Williams
Associate Professors 11Bennetto, 1Brown, 1Crane, 1Dickerson, 1Freedman, 11Fudge, 11Halterman, 1Kammermeier, 1Libby, 1Luebke, 1Magirwar, 1Majewska (Director), 11Mayer-Proeschel, 11Nehrke, 1O’Neill, 1Olschowka (Associate Director), 1Opanashuk, 11Portman, 1Romanski, 1Seidman, 1Tadin
Assistant Professors 1Cantlon, 17Ghaemmaghami, 1Hayden, 1Holt, 1Hunter, 1Kiernan, 1Mahon, 13Proeschel, 10Takano, 5White

The Interdepartmental Graduate Program in Neuroscience provides a comprehensive, research-intensive training experience for students seeking a PhD degree in the study of the nervous system. Over 60 faculty members serve as mentors for students, representing 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.

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 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.

Primary appointments are in the following departments: 1 Brain and Cognitive Sciences, 2 Pharmacology and Physiology, 3 Microbiology and Immunology, 4 Environmental Medicine, 5 Neurobiology and Anatomy, 6 Anesthesiology, 7 Otolaryngology, 8 Neurology, 9 Ophthalmology, 10 Neurosurgery, 11 Psychiatry, 12 Biomedical Engineering, 13 Biomedical Genetics, 14 Pediatrics, 15 Clinical and Social Sciences in Psychology, 16 Medicine, 17 Biology
503. Neuroscience Student Seminar
(Same as NSC 503 and ANA 522)
Credit—one hour
This course provides students a forum for developing and refining their oral presentation skills and for getting feedback on their research. Students deliver an annual seminar on their thesis research. Following each presentation, audience members complete an evaluation to provide the presenters with feedback on various aspects of their presentation. (Fall and Spring)

508. Neural Plasticity in Learning and Development
(Same as NSC 508 and BCS 508)
Prerequisite: BCS 507 or equivalent.
Credit—three hours
This course provides an examination of neural plasticity in development as well as in adult learning and memory. Specific topics are approached from the complementary perspectives that emerge from work in molecular, cellular, behavioral, computational, and psychophysical fields of neuroscience research. (Spring, alternate years)

511. Human Brain Anatomy
Prerequisite: NSC 512 or permission of instructor.
Credit—one hour
This introduction to human brain anatomy is based on a series of laboratories developed for medical students, although the emphasis for this course is on relating structure to function rather than diagnosing neurological conditions. The major goal is to gain an understanding of basic brain structures from standpoints of anatomy, organization, and function. A series of lectures provides additional information and explanations to complement concepts learned in the laboratories. (Spring)

512. Cellular Neuroscience
Credit—five hours
This course provides an advanced understanding of the biochemical, molecular, and cellular properties of the nervous system as well as its organization and development. The first section covers the electrical properties of neurons, the molecular properties of ion channels, and the organization of receptors and channels at the synapse. This is followed by an explanation of the biochemical and pharmacological properties of neurotransmitters and their receptors, sensory transduction mechanisms, and mechanisms of signal transduction in neurons. The final unit discusses the molecular and genetic processes that govern nervous system development. (Fall)

513. Introduction to fMRI: Imaging, Computational Analysis, and Neural Representations
(Same as NSC 513, BME 513, and PHY 513)
The core focus of the course is on how fMRI can be used to ask questions about neural representations and cognitive and perceptual information processing. The course addresses questions about neural representations and neural information processing, ways of relating neural activation to behavioral performance, and whether fMRI can provide information over and above what can be obtained from behavior alone. Part of the class focuses on aspects of MRI physics and physiology, which make fMRI possible. (Spring)

525. Biology of Neurological Diseases
Prerequisite: NSC 512 or permission of instructor.
Credit—three hours
This course explores the neurobiological basis of human neurological disease, emphasizing the relationship between behavioral dysfunction and neuropathology or neural dysfunction. While this is an overview, we emphasize those diseases for which significant information is available in terms of genetic or molecular control of disease mechanisms or therapeutic approaches. The course is designed for graduate students in neuroscience or in other disciplines who have a background in neurobiology. (Spring, alternate years)

531. Integrative and Systems Neuroscience
Prerequisites: NSC 511, 512 or NSC 201/BCS 240 or (equivalent introductory neuroscience course) with permission of instructor.
Credit—six hours
This course provides a critical overview of current knowledge of systems neuroscience. The topics include an overview of approaches and techniques, a comprehensive account of functional connectivity, transmitters, neurophysiology, and behavioral measures of sensory and motor systems, the basal ganglia, the autonomic limbic and hypothalamic systems, as well as memory, attention, and cognition. (Spring)

547. Introduction to Computational Neuroscience
Prerequisites: graduate standing in BCS, NSC, or CS, or permission of instructor.
Credit—three hours
This course reviews 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 ends with models of complex cognitive functions such as sensory motor transformations or sentence processing. (Spring)

581. Teaching Tutorial in Neuroscience
Credit—three hours
This experience provides an opportunity for students to acquire and develop skills in teaching and course management in neuroscience. Students assist in teaching NSC 201 or NSC 203 and are expected to attend staff meetings, provide instruction in the laboratory, bear responsibility for small-group teaching, assist in the preparation and grading of examinations and papers, and participate in staff-evaluation sessions. (Fall and Spring)

590. Lab Rotations in Neuroscience
Credit—to be arranged
Laboratory rotations are intended to familiarize students with the individual laboratories and areas of research where they may eventually want to pursue their thesis work. Rotations also provide an opportunity to learn and master new techniques and to gain
an appreciation for different scientific approaches to a problem. Rotations are planned in consultation with the first-year faculty advisor. (Fall, Spring, Summer)

591. PhD Readings
Credit—to be arranged
PhD Readings are individualized readings courses in which students gain in-depth familiarity with theoretical issues and experimental approaches on a specific topic in neuroscience. The course is guided by an instructor selected by the students from members of the neuroscience faculty. The instructor meets with the students on a weekly basis to assist in the selection of relevant readings and to discuss the key issues. Grades are based on a term paper or on an oral examination administered by the instructor and other participating faculty. (Fall and Spring)

592. Neuroscience Journal Club
Credit—one hour
This is a seminar/reading course for first- and second year neuroscience graduate students focused on current topics in neuroscience research. The objective is to gain experience discussing and critically evaluating primary research articles covering a broad range of topics in neuroscience. (Fall and Spring)

595. PhD Research
Credit—to be arranged

Center for Oral Biology

Professors Quivey (Director), Hsu, *Shuttleworth, *Yule
Associate Professors *Haidaris, Lemos, Ovitt
Assistant Professors Abranches, *Friedman, Arany
Professor Emeritus Bowen

The principal objective of the Center for Oral Biology is to train the next generation of scientists in research related to oral health and disease for academic careers. These individuals would include basic scientists, dentists, and other qualified persons. In pursuit of these aims, the center cooperates closely with the basic science departments of the School of Medicine and Dentistry and the College. There is close cooperation with the other components of the Eastman Institute for Oral Health, as well as departments of the School of Medicine and Dentistry, such as the Departments of Medicine, Microbiology and Immunology, Pediatrics, and Physiology and Pharmacology. Joint degree programs are offered with these various departments.

Graduate students who hold appointments in the Center for Oral Biology may work for the PhD degree in disciplines including anatomy, biochemistry, biology, biophysics, genetics, microbiology and immunology, neuroscience, pathology, pharmacology, physiology, or toxicology. Entrance requirements are in accordance with the policies of the individual departments, centers, and programs. The PhD candidate is registered in the department or center in which the degree will be granted. Classes and seminars are attended, and a research program directed toward the solution of some problem pertinent to oral science is carried out in the appropriate basic science department or center. 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 master’s degree in dental sciences is primarily directed to students who have already completed dental school, though the program is open to non-dentists who have completed a bachelor’s degree and demonstrate a strong interest in problems related to oral biology and disease. The program consists of four areas of emphasis, or tracks, including the following: Infectious Disease, Exocrine/Ion Channel Biology—Regenerative Oral Biology, Craniofacial Development and Genomics, and Clinical/Translational Research. Studies leading to the master’s degree in dental sciences will typically cover two to three calendar years and require a total of at least 30 hours of credit consisting of 18 hours of didactic coursework and 12 hours for research. Predoctoral candidates are considered for the master’s program in special circumstances. Each student is required to participate in didactic courses and seminars offered by the University of Rochester Medical Center. In addition, all candidates must choose a particular area in the sciences as a minor (biochemistry, pharmacology, etc.) for advanced study and to develop knowledge in this field by attending appropriate courses. The candidate must also conduct a research project in an area of oral biology. The results of this work must be presented in a thesis acceptable to the candidate’s committee. Fellowship

* Primary appointment in another department
stipends sufficient to meet living costs are available to selected students on a competitive basis.

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. A sampling of courses offered in the training programs of the Center for Oral Biology are shown below.

**414. Mechanisms of Microbial Pathogenesis**
Prerequisite: MBI 220 and 221.
Graduate students register for MBI 514 seminar
Credit—four hours undergraduate, three hours graduate

The course provides an examination of host-pathogen interactions and details the mechanisms microbes use to evade the immune response and cause disease. The emphasis is on a molecular-level understanding of microbial pathogenesis, including colonization, invasion, antigen variation, toxin production, and mode of virulence factor action. In addition, how host defense mechanisms interact with pathogenic microbes is examined. (Alternate years)

**495. MS Research**
Prerequisite: BS, for projects in basic sciences; DDS, DMD, or equivalent for projects involving clinical sciences.

The research program of the dental fellows is usually directed toward the solution of some problem pertinent to dentistry. Laboratory facilities are available in the Center for Oral Biology, the Eastman Department of Dentistry, and the preclinical departments of the School of Medicine and Dentistry.

**501–504. Dental Research Seminar**
Prerequisite: permission of instructor.
Credit—one hour each term

The purpose of this series is to provide experience to participants in preparing, organizing, and presenting material to a critical audience. The fall semesters are devoted to a systematic review of recent significant research developments in one of the basic sciences fundamental to oral biology. In the spring semesters, the students report on original research. Required of all graduate students in oral biology and open to other graduate students and dentists.

**556. Biology of the Periodontium**
Prerequisite: permission of instructor.
Credit—one hour

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)

**558. Growth and Development**
Prerequisite: permission of instructor.
Credit—one hour

This series 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)

**563. Pharmacology and Therapeutics**
Prerequisite: permission of instructor.
Credit—one hour

Pharmacotherapeutics of drugs most often used in dentistry are reviewed with emphasis on critical analysis of the related literature and current directions in pharmacological research. (Fall, odd years)

**570. Oral Epidemiology I: Principles and Practice**
Credit—one hour

Students are introduced to the fundamentals of epidemiology. Emphasis is placed on the natural history of common dental diseases. (Fall)

**571. Oral Epidemiology II: Research Design and Analysis**
Prerequisite: ORB 570.
Credit—one hour

This is the second course in the pair with 570. (Spring)

**579. Saliva and Salivary Glands**
Prerequisite: permission of instructor.
Credit—one hour

This course gives students an understanding of the fundamental biology of the salivary glands. The regulation of salivary gland physiology is discussed, as is the structure/function relationship of salivary proteins and lipids. The developmental principles and molecular basis of salivary gland gene expression is explored. The etiology, pathogenesis, and consequences of salivary gland diseases are discussed. Current topics in regenerative therapies are also covered. (Spring, even years)

**580. Fundamentals of Dental Caries**
Prerequisite: permission of instructor.
Credit—one hour

This course presents the latest developments in many aspects of dental caries, from the most fundamental basic science to clinical applications. (Fall)

**581. Fundamentals of Oral Microbiology**
Prerequisite: permission of instructor.
Credit—two hours

The major groups of microorganisms causing oral disease are reviewed with emphasis on basic biology, genetics, physiology, and pathogenic mechanisms. (Fall, odd years)
Pathology and Laboratory Medicine

The Department of Pathology and Laboratory Medicine offers a program of education and research leading to the degree Doctor of Philosophy in pathology. While the program is sponsored by the Department of Pathology, the participating faculty are drawn from at least 16 departments. This provides diverse education and research experiences and thesis opportunities for the student. The graduate program in pathology is designed for the student who wishes to pursue independent careers in research and teaching. Through coursework, seminars, and research experiences, the student will be well prepared to address the complex but rewarding problems in human disease in either an academic or industrial setting.

The first year of the Pathways of Human Disease Graduate Program (PWD) is designed to give trainees 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. Most students choose to remain in the graduate program in pathology. The thesis advisor need not be a member of the PWD Graduate Program faculty but must provide a strong training and educational environment. Students follow a disease-oriented curriculum in elective studies and advanced coursework during the second year.

The faculty of the graduate program in pathology represent at least 16 departments within the Medical Center and offer many exciting research opportunities to students. 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, and gene products. Diseases under active investigation include diabetes; cardiovascular disease; osteoporosis; breast, prostate, and bladder cancer; and arthritis to name just a few. Several experimental approaches used by our students include production of new molecular and immunological probes for genes and their products, quantitative high-resolution image analysis of cells and tissues, quantitative single-cell measurements by flow cytometry and cell sorting, receptor biology and signal transduction, and RNA processing.

504. Current Topics in Experimental Pathology
Prerequisite: permission of course director.
Credit—one hour

This course uses the seminar format to introduce students to diverse experimental and intellectual approaches to studying disease processes. The seminar format provides valuable experience in oral presentations by presenting their current research work to the faculty and fellow students on a yearly basis. Evaluation by both faculty and students provides an essential element of critique in the student’s research process. (Fall and Spring)

507. Cancer Biology
Prerequisite: permission of course director.
Credit—three hours

The goal of this course is to provide a solid background and current understanding of cancer biology and cancer-related research. The lectures will cover key topics in cancer biology, including intrinsic regulatory mechanisms of cancer cell proliferation, the impact of microenvironment on tumor growth and metastasis, and the diagnosis and prognosis of cancer. Leading scientists in the cancer research field deliver lectures on each topic and lead in-depth discussions centered on groundbreaking findings. The advanced-level course emphasizes original experiments and critical thinking and reading of the primary literature rather than abstract facts and memorization. Active participation and in-class discussions among students are expected. This course is offered as a mandatory requirement for postdoctoral fellows on the Cancer Center Training Grant and as an upper-level elective for graduate students campus-wide. (Spring)

509/510. Pathways of Human Disease I and II
Prerequisite: permission of 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 learn the basic anatomy, histology, and physiology of all major organ systems in the context of examples of human disease. They complete the course with an understanding of the basic principles of human disease processes at the whole animal, organ, cellular, and molecular levels. They also gain insight to 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. There are three weekly sessions—two didactic and one laboratory. Laboratory exercises use the vast resources of the Medical Center to provide practical experience in current and cutting-edge application of biomedical science to medicine. (Fall I, Spring II)

571. Molecular Basis of Human Disease
Prerequisite: permission of course director.
Credit—three hours

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 is placed on the current understanding of disease processes, limitations, and strategies for innovative experimentation that should lead to breakthrough discoveries and cures. Discussions address various diseases including, but not limited to, cardiovascular, neurological, and hematological abnormalities; autoimmunity; endocrine defects; and cancer. Each week covers one specific topic that is composed of a lecture and a journal club. Students are assigned scientific papers of interest and present and discuss these papers with their peers at the second session provided by each faculty. (Fall)

595. PhD Research
Credit to be arranged

PhD research is done under the direction of a faculty member of the Medical Center with the approval of the graduate program in pathology.

Pharmacology and Physiology

Research Associate Professor *Krieger
Research Assistant Professors Lehman, Malik, Yarotsky
Adjunct Professor *Morse
Adjunct Associate Professor Anaizi
Adjunct Assistant Professor *Ma
Professors Emeriti Anders, Begenisich, Blair, Hinkle, Peracchia, Rivera-Calimlim

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.

In general, a bachelor’s degree in biology or chemistry is the preferred undergraduate training for entrance. These courses are ordinarily required for admittance to the PhD program in pharmacology and physiology: introductory courses in organic and physical chemistry, biology and biochemistry; 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). Second-year courses are selected from a menu of electives.

403. Human Cell Physiology
Credit—four hours

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, are discussed. The material includes basic
concepts, principal research questions, and common methodologies—emphasis is on a quantitative approach wherever possible. Course content particularly focuses on basic cellular physiology, including excitable cell physiology, and emphasizes intercellular interactions and responses to their tissue and organ environment. Recent literature relevant to the material is reviewed and analyzed during the course. (Fall)

404. Principles of Pharmacology
Prerequisite: PHP 403 or permission of course director.
Credit—four hours
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 at the University of Rochester. It focuses on the fundamental principles of pharmacology, neuropharmacology, cardiovascular pharmacology, and contemporary approaches to drug discovery and design. (Spring)

440. Topics in Vascular Biology
Prerequisite: graduate physiology recommended and permission of instructor.
Credit—two hours
This course provides an in-depth coverage of selected topics in vascular biology. Major topics and concepts are introduced in the context of current literature. These include vascular functional anatomy, angiogenesis, hemodynamics, vascular control mechanisms, vessel-blood interactions, signaling, mechanotransduction, leukocyte-endothelial cell interactions, vascular disease, and gene therapies. (Alternate springs)

447. Signal Transduction
Prerequisites: IND 408 and 409.
Credit—four hours
Cellular signal transduction is one of the most widely studied topics in the biomedical sciences. It has become clear that cells have multiple mechanisms for sensing the environment and converting the external signals into intracellular responses that are important for regulation of human physiology. The goal of this course is for students to learn modern concepts in signal transduction. The lectures cover a spectrum of topics ranging from basic principles and mechanisms of signal transduction to contemporary techniques for doing research in this area. (Spring)

502. Seminar
Credit—one hour each term
Research presentations given by students, staff, faculty, and outside guests. Organized survey of selected fields may be presented upon request.

550. Ion Channels and Disease
Credit—two hours
It has become increasingly (and not surprisingly) clear that ion channel and Ca^{2+}-signaling proteins are often the targets of disease mechanisms and therapeutic drugs. This course is designed to provide an advanced understanding of the basic properties of ion channels and Ca^{2+}-signaling systems and an appreciation of some of the functional modifications in these proteins produced by genetic defects. These topics are examined through readings of classic and current papers of the original literature that is integrated with didactic material where useful. It wasn’t that long ago that many folks weren’t sure that ion channels were actually channels. The application of mathematics and physics to electrophysiology was quite successful in uncovering many of the structural features later confirmed by the more direct method of X-ray crystallography. Of course, at present, the relevant crystallographic techniques cannot produce time-resolved pictures, so essentially, all of our understanding of dynamic ion channel function comes from combining some form of voltage clamp technique with other methods. The first several weeks the course covers some of these “biophysical” approaches that are widely used in investigations of ion channel structure and function. (Alternate springs)

593. Special Topics in Pharmacology and Physiology
Credit to be arranged
Directed studies in the field of pharmacology or physiology, supervised by a faculty member and organized to meet the needs of individuals or small groups of graduate students. May involve supervised readings, laboratory exercises, or organized discussions.
Public Health Sciences

The Department of Public Health Sciences offers programs of study leading to the degrees of master of public health, master of science in both clinical investigation and health services research and policy, 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 44 credit hours. It can be completed in two years of full-time study. The master of science in clinical investigation (MS-CLI) is 33 credit hours and the (MS-HSRP) is 37 credit hours. They both can be completed in one full-time or two part-time years of study. Required courses for both tracks include epidemiology, biostatistics, research methods, social and behavioral factors affecting health and illness, 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 using epidemiological and other analytic methodologies. 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 capable 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.

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The Department of Public Health Sciences is housed on the third floor of the Saunders Research Building.

410. Introduction to Data Management and Analysis Using SAS
This course, targeted at MPH students, provides an introduction to the SAS analytic software as applied to the management, analysis, and reporting of clinical and public health data. Building on linkages to the department’s biostatistics and epidemiology curriculum, this course emphasizes the integration of SAS into the research environment and the development of extensible statistical computing skills. Students gain familiarity with the SAS system through a combination of collaborative lab sessions, homework assignments, and illustrative public health examples. To enroll, students must have (i) a working knowledge of Microsoft Windows and (ii) be familiar with basic statistical concepts (as covered in BST 465 or an equivalent course). Due to class size and availability of computing resources, no audits of this course are permitted.

412. Survey Research
Prerequisite: PM 415 or permission of the instructor.
This course presents students with an overview of the role of survey methods and tools in the research process, with a particular focus on survey research applications in health care research and epidemiology. The course incorporates an integrated perspective, which includes a qualitative approach to conducting appropriate and accurate survey research. Students participate in all stages of the survey research process through application of homework assignments. (Spring)

413. Field Epidemiology
Prerequisite: Introduction to Epidemiology or permission of the instructor.
This course provides an overview of the practical applications of theoretical epidemiological concepts in the study of the distribution of diseases and their causes in populations. Emphasis is 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. (Spring)
414. History of Epidemiology
The overall goal of this course is to focus the attention and raise the awareness of students on the historical perspectives of epidemiology. The course familiarizes the student with the growth of epidemiology, as a basic science, and shows 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 emphasizes the relationship between epidemiology and other scientific disciplines by demonstrating the influence of methodological techniques used by epidemiologists. Additionally, the framework of this course fosters an appreciation for the role of epidemiology in society through its impact on public health and the impact of society and its norms on the growth of epidemiology. (Fall, alternate years)

415. Principles of Epidemiology
Introduction to epidemiology is intended to provide an overview of concepts dealing with the study of the distribution of diseases and their causes in populations. It defines epidemiologic terms, introduces methods used to describe diseases in populations, provides an overview of ways to determine the causes of disease, and applies epidemiologic principles to the evaluation of preventive and therapeutic interventions. This is carried out by lecture presentations supported by laboratory problems and small group discussions. The course uses L. Gordin, Epidemiology, 4th Edition. Philadelphia: W. B. Saunders Co., 2008, as a textbook, supplemented with additional readings. (Fall)

416. Advanced Epidemiologic Methods
Prerequisites: PM 415 and one semester of graduate-level statistics.

This course provides an in-depth coverage of the quantitative methodological issues associated with population-based epidemiologic research. Issues specific to study design, conduct, and analysis are emphasized. Topics covered include issues in study design, selection and information bias, topics in measurement, confounding, effect modification, and multivariate analytic techniques including linear and logistic regression, Kaplan Meier survival analysis, and Cox proportional hazards modeling. As part of the course, SAS programming is reviewed in a separate laboratory session; however, previous coursework using SAS is recommended. (Spring)

417. Molecular Epidemiology
Using the same paradigm as traditional epidemiology, this course explores the opportunities for the use of increasingly powerful biologic markers of exposure, disease, and susceptibility to provide high-resolution answers in relation to the causes of disease. The course focuses 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. (Spring)

418. Cardiovascular Disease Epidemiology and Prevention
At the completion of the course, students are able to demonstrate their knowledge of cardiovascular disease epidemiology and prevention by listing and/or discussing the proven risk factors for coronary heart disease (CHD) and the seminal studies leading to their discovery. Other important topics students should describe are the emerging risk factors for CHD, strategies and interventions for preventing CHD, and the differences between risk markers and risk factors. Students should also 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 EPI and prevention and how they have arisen. (Fall)

419. Recruitment and Retention of Human Subjects in Clinical Trials
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 subject or participant. While these concerns are important, successful and sustainable recruitment and retention extends well beyond protocol design. This course focuses on strategies to recruit and retain subjects from groups known to be “hard to recruit” such as individuals from disenfranchised communities (racial/ethnic minorities, homeless) and other subgroups such as the elderly. This course combines online work with in-class discussion and presentations from individuals responsible for clinical research recruitment and retention. Participants critique and design recruitment strategies from published reports and local research, develop feasibility assessments, and draft a recruitment plan. (Fall)

420. American Health Policy and Politics
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 mid-1990s, readings and seminar discussions focus on political forces and institutions and on historical and cultural contexts. Among the topics covered are periodic campaigns for national health insurance efforts to rationalize and regionalize health care institutions, 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, and the formation and failure of the Clinton administration’s health reform agenda. (Fall)

This course examines the organization, financing, delivery, and performance of the U.S. health care system. The inherent trade-offs 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
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 introduces 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 Diseases
Prerequisite: PH 103 or 415.
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 that involves them.

425. Health Promotion and Preventive Medicine
This course provides 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 of 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.

426. Social and Behavioral Medicine
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. (Fall)

428. Health Services Research Seminar
A noncredit course required of all doctoral and postdoctoral students. A variety of topics is presented for discussion by faculty and students.

430. Psychology in Health Services Research
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, health care 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)

438. Practical Skills in Grant Writing
This course is intended to provide the attendee interested in an investigative career in the biomedical and behavioral sciences with practical skills related to procuring external support for research. The course content includes didactic lectures on grant-related topics, discussion sessions with the opportunity to examine grants that others have written, examination of tools and resources available to assist in grant writing, and the opportunity to write a grant application for the support of the trainee’s own research project and have it critiqued. At the end of the course, the enrollee should be able to write a research grant application for submission. This course focuses on how to find appropriate grant funding opportunities, the fundamentals of grant requirements in common with most all funding agencies, as well as some requirements unique to certain funding agencies, including foundations, NIH, non-NIH federal agencies, and community-based funding opportunities. (Spring)

442. Nutritional Epidemiology
Prerequisites: introductory courses in epidemiology and statistics.
This course is designed to give students the tools to critically review the nutritional epidemiologic literature and to conduct epidemiologic studies of diet, nutrition, and disease. Concepts on nutritional epidemiology are applied to nutrition and nutritional-related disorders prevalent in the United States and globally (e.g., descriptive epidemiology of breast-feeding, obesity). (Spring)

445. Introduction to Health Services Research and Policy
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.” (Fall)

448. Health Policy Analysis
This course introduces the students to a variety of tools that are used to analyze governmental health policy. The tools and concepts are those found in economics (e.g., market analysis, efficiency), political science (e.g., analysis of voting behavior, interest groups, public opinion), and econometrics (e.g., regression analysis). Class discussions are based primarily on selected journal articles. (Spring)
450. Governance and Management of Community Health Services Organizations
Community-based organizations are important partners in public health as service providers, educational study and research sites, and collaborators in community engagement. The principal objective of this practicum is to understand how these organizations function in addressing critical community issues relating to the social and environmental determinants of health. Students work in teams, each team selecting a specific area of need, e.g., infant health, and focusing on agencies and programs, governmental as well as nonprofit, that address this need. Each team is responsible for four presentations and reports on what it has learned, including documentation of need, objectives, and effectiveness of existing programs and policies; and recommendations for increasing community impact. Class activities include guest speakers and discussion based on readings or case studies. (Fall)

451. Infectious Disease Epidemiology
This course examines the epidemiology of infectious diseases within a biological and methodological framework. Students are introduced to the objectives of conducting research in infectious diseases and the methodologies used to accomplish these objectives. There is a particular focus on topics not applicable to the study of chronic diseases, such as vaccination, immunity, and transmission dynamics. Students also gain an appreciation for the public health importance of specific pathogens in the United States and globally. (Spring)

452. Community Health Improvement Practicum
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. Student group projects are responsible for conducting a community health-improvement intervention in the Rochester community during the semester in close partnership with community agencies (e.g., NGOs, American Cancer Society, Monroe County Health Department, Charles Settlement House, Faith-based Organizations, Rochester City School District, Healthy Start, Sojourner House, and many more). (Fall)

456. Advanced Health Economics I: The Industrial Organization of Health Care Markets
Prerequisites: ECO 207 or 471 and calculus.
This is an introductory course that covers 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 uses graphs and calculus-based mathematical models to communicate main concepts and principles. (Fall)

458. Qualitative Health Care Research
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 sociocultural 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 key terminology for accurate survey development. This course covers 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 supervision of and consultation with an essay advisor and an advisory committee.

461. Program Evaluation for Public Health
This course provides 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 helps 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 learn the theories behind program evaluation and how to prevent or overcome common evaluation planning and implementation challenges and pitfalls. Students 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)

463. Introduction to Mathematical Statistics, Part I
The goal of this course is to familiarize students with basic elements of probability and mathematical statistics. At the completion of this course, students are familiar with set theory and notation and with special distributions, both discrete and continuous; understand probability theory; learn how to approach functions of random variables; and comprehend limit theorems in statistics. (Fall)

464. Introduction to Regression Analysis, Part II
Prerequisite: PM 463 or permission of instructor.
The course focuses on becoming familiar with the theory of ordinary least squares regression analysis and its assumptions as well as the necessary alterations required to conduct valid analysis when those assumptions are not met. To the extent possible, examples are taken from the health services research literature. (Fall)
465. Applied Advanced Multivariate Analysis, Part III

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)

469. Multivariate Models for Epidemiology

The purpose of this course is to provide students with a strong understanding of and experience in the more advanced quantitative methods for the analysis of epidemiologic studies. A more detailed presentation of the analysis issues of confounding and interaction is presented and a complete presentation of most multivariate techniques.

470. Environmental and Occupational Epidemiology

The objective of this course is to provide an overview of environmental issues related to public health. Physical, social, and psychological environmental issues are addressed through readings, lectures, and discussions as well as field trips and site visits. Selected environmental issues are addressed from the perspective of impact on public health (history and current public health). (Spring)

472. Measurement and Evaluation of Research Instruments

The purpose of this course is to provide students with a comprehensive background in the development and testing of self-report research instruments for epidemiologic research purposes. A review of the principles of survey development begins the course; however, it rapidly moves to a more hands-on approach as students 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. Students 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.

476. RCTRC Seminar Series

A weekly seminar series for Rochester Clinical Translational Research Curriculum participants. This series includes presentations from University of Rochester training mentors, guest lecturers, experts in technological innovations in clinical research, as well as trainee presentations.

478. Workshop in Scientific Communication

Required of all Rochester Clinical Research Curriculum trainees and open to trainees in other programs. This workshop addresses scientific writing; abstract preparation; poster creation and presentation; oral presentation dos and don'ts; response to manuscript reviews and critiques; performance of manuscript reviews; Word, PowerPoint, Excel, and 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). Students are required to complete one writing/presentation assignment (scientific manuscript, review article, poster presentation, abstract and oral presentation, or sections of a grant/thesis proposal). This is an excellent opportunity for those taking Practical Skills in Grant Writing (PM 438) to hone overall writing skills. (Spring)

479. Health, Medicine, and Social Reform

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 is also 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, alternate years)

480. Changing Concepts of Disease

Historical account of the way disease has been conceptually understood in the Western tradition. Emphasizes the scientific, epidemiological, philosophical, social, cultural, and professional forces that have shaped the development of ideas. (Spring, alternate years)

483. Advanced Health Economics Part II

Prerequisites: ECO 207 or 471, Health Economics I, and calculus.

The study of how three major parties in the health care system—insurers, hospitals, and physicians—interact and how the nature of these interactions affects the system's overall economic performance. (Spring)

484. Medical Decisions and Cost-Effectiveness Research

Prerequisite: at least one semester of graduate-level statistics.

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 also learn decision analysis software such that they can perform analyses themselves as a class project. After completion of the course students (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)

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 B. Paige Lawrence (Program Director), Cory-Slechta, Dean, Finikelstein, Frampton, R. S. Freeman, Gasiewicz, Georas, Hinkle, Johnson-Voll, R. K. Miller, Mooney, Noble, Oberdörster, O’Banion, O’Reilly, Phipps, Pryhuber, Puzas, I. Rahman, Sime, Topham, Williams
Associate Professors DeLouise, Elder, Majewska, Mayer-Pröschel, Opanashuk, Portman, A. Rahman, Rich, van Wijngaarden, Zuscik
Assistant Professors Benoit, Friedman, Rand

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 30 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 inflammatory mediators of inflammation contribute to the ontology 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.

### 470. Environmental and Occupational Epidemiology

**Credit—one hour**

This is an intermediate-level course designed to familiarize students with the conduct of environmental and occupational epidemiology studies. Students 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 is on the application and interpretation of epidemiologic methods and findings in environmental and occupational health. Students are asked to analyze, evaluate, summarize, and present published studies used to investigate health effects related to environmental and occupational exposures. (Spring)

### 501. Forensic Pathology for Toxicology

**Prerequisite: permission of the instructors. Credit—one hour**

This seminar course introduces the discipline of forensic pathology to the toxicologist and examines the application of forensic pathology to criminal and civil investigations. Topics include introduction to systems for the medico-legal investigation of death, conduct of a forensic autopsy, investigation of criminal poisoning, investigation of accidental and suicidal poisoning, investigation of thermal and electrical fatalities, investigation of gunshot and wounds due to explosions, investigation of human and animal abuse, investigation of deaths due to impairment of respiration, the pathophysiology of death, and determination of the time of death. (Fall, even years)

### 502. Forensic Toxicology

**Prerequisite: permission of the instructor. Credit—one hour**

This is a seminar course that examines the application of the physical and biological sciences to criminal investigation. Topics include forensic pathology, forensic chemistry, forensic archeology, forensic anthropology, forensic entomology, forensic toxicology, forensic dentistry, forensic engineering, forensic ballistics, fire and explosion investigations, engineering failures and accidents, and forensic computing. (Fall, odd years)
**521. Biochemical Toxicology**  
*Prerequisites: IND 408, PHP 407, and permission of course director.  
Credit—four hours*  
A study of the actions of toxic substances. Prediction of exposures, doses and critical cellular concentrations, adverse effects in organisms, and responses in populations. Mechanisms leading from reactions with molecular ligands to pathological signs and symptoms are emphasized. This course introduces principles and current theories of biochemical and molecular mechanisms, as they apply to certain organ systems including kidney, immune system, skin, pulmonary system, and nervous system. (Spring)

**522. Organ Systems Toxicology**  
*Prerequisite: TOX 521.  
Credit—four hours*  
This course continues TOX 521 with a discussion of mechanisms of reproductive toxicology and carcinogenesis. The selective toxicity of certain chemicals is discussed to emphasize dose dependency and mechanisms of action. Finally, current issues and principles applied to the environment, clinical toxicology, modeling, and risk assessment are discussed. (Fall)

**530. Reproductive and Developmental Toxicology**  
*Prerequisite: either medical school pharmacology or PHP 408, or TOX 521.  
Credit—two hours*  
This course emphasizes the problems associated with infertility, embryonic development, maternal physiology, and postnatal growth following exposure to environmental and therapeutic agents. (Spring, even years)

**533. Neurotoxicology**  
*Credit—one hour*  
This is a special topics course where subjects are presented and discussed in depth. For example: environmental risk factors for neurodegeneration, developing nervous system as a target for neurotoxicity, glia as targets for neurotoxicity. (Spring, even years)

**558. Seminar in Toxicology**  
*Credit—one hour*  
Seminars by students examine critically the published research on selected problems in toxicology. Required of toxicology doctoral candidates. (Spring)

**564. Pulmonary Toxicology**  
*Credit—one hour*  
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)

**592. Immunotoxicology**  
*Credit—one hour*  
Selected topics relevant to current issues and problems in immunotoxicology and immunopharmacology are covered. The course director provides an overview of this field of study in a brief series of lectures. The students then identify and lead discussion on relevant focus topics of their choosing. The course draws on recent peer-reviewed publications and/or reviews that are discussed and critiqued by the participants in a journal club-style format. (Spring, odd years)

**594. Gene Environment Interactions**  
*Credit—one hour*  
The broad aims of this course are to understand how genes and environment interact and influence human health and disease, with a specific focus on pulmonary and neuronal diseases. The course format involves reading current scientific literature with an emphasis on understanding techniques/methods that provide insight into mechanisms underlying complex genetic and environmental interactions that influence human health. In this journal-club style course, the course directors provide an overview of this field of study and lead discussion on one scientific paper. The students then identify and lead discussion on scientific papers of their choosing that have been approved by course directors. (Fall, even years)

**595. PhD Research in Toxicology**  
*Credit to be arranged*
School of Nursing

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**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) 474-3862. The Master’s and Doctor of Nursing Practice (DNP) graduate programs are fully accredited by the Commission on Collegiate Nursing Education, One Dupont Circle NW, Suite 530, Washington, D.C. 20036, (202) 887-6791.

**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.

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 seven 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.
4. Completed PhD application.
MS-PhD Dual Degree Programs

For highly motivated students with strong academic promise, seven 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.

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. The program design integrates PhD courses with master’s-level courses from the first semester onward. 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 91 to 102 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 usually require a minimum of three and one-half years to complete the program. Minimum completion time for the MS-PhD combined programs is four and one-half years of full-time study.

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 nurse practitioners to lead the delivery and evaluation of evidence-based, patient-centered care; synthesize research findings to develop and/or refine practice guidelines; and integrate information
technology into the management, application, and evaluation of patient care. DNP graduates assume roles in a wide variety of direct and indirect care roles such as direct care clinicians, quality improvement directors, health care administrators, faculty members, political appointees, and policy advocates.

Consistent with the other doctoral programs within the University of Rochester, students in the DNP program are required to complete a minimum of 90 credits as well as a minimum of 1,000 post-baccalaureate clinical hours. Students complete coursework in evidence-based practice and translational research including advanced statistics and epidemiology; leadership, systems management, and strategic planning; health policy, informatics, and interprofessional partnerships. At the completion of the program, students are required to defend an evidence-based capstone project, the practice doctorate’s equivalent to a PhD research dissertation.

Students may enter the DNP program as post-baccalaureate students or post-master’s students. Credits may be transferred from a previous master’s program to achieve the 90 credits required for degree completion. Both full-time and part-time study is permitted. Students admitted to the full-time post-baccalaureate DNP program usually require four years to complete the program. Those admitted to the full-time post-master’s DNP typically complete the program in two years. Sample program plans are available on request.

**Admission Criteria**

- Bachelor’s or master’s degree in nursing
- RN licensure within the United States or U.S. territory
- Cumulative GPA of 3.0 for undergraduate work and 3.5 for graduate work (preferred)
- Completed DNP application including essay/personal goal statement, writing sample, and curriculum vitae or resume
- Competitive scores on the Graduate Record Examination (general test only) or successful completion of an accredited doctoral program
- For international students for whom English is not the primary language or who did not complete their degree in nursing in an English speaking country, Test of English as a Foreign Language (TOEFL): minimum scores required as follows: above 560 (regular paper test) or above 230 (regular computer test) or 88 (new “I-based” test).
- National certification (if available) in advanced nursing practice specialty area
- Favorable interview with at least two faculty members delineating motivation and goals for doctoral study and advanced nursing practice
- Four positive letters of recommendation: at least one from an academician, at least one from a supervisor in an employment setting, at least one from a doctorally prepared professional, and at least one from a practicing Registered Nurse. Taken together, these references should speak to the applicant’s intellectual ability, clinical proficiency, academic achievement, and professional commitment.

**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](http://www.son.rochester.edu).

**Accelerated BS and MS for Registered Nurses**

This is an accelerated bachelor 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 licensure.

Course descriptions for year-one baccalaureate-level coursework in the AMPNN can be found in the [Official Bulletin, Undergraduate Studies](http://www.rochester.edu/UndergraduateStudies) (also on the web at [www.rochester.edu/Bulletin](http://www.rochester.edu/Bulletin)).

**Master’s Programs**

The School of Nursing offers Master of Science degrees with a clinical concentration (nurse practitioner programs or clinical nurse leader) or a leadership focus (health care management and leadership or clinical research coordinator [not currently accepting applications]). 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 leadership program is an interdisciplinary program for both nurses and other health care professionals ready to take their career 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 42 to 61 credits in addition to 560–960 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 Acute Care Nurse Practitioner (Cardiovascular, Critical Care), Adult Nurse Practitioner, Adult/Geriatric Nurse Practitioner, Pediatric Nurse Practitioner, Pediatric Nurse Practitioner/Neonatal Nurse Practitioner, Family Nurse Practitioner, Gerontological Nurse Practitioner (Post-Master’s only), Family Psychiatric/Mental Health Nurse Practitioner Program.

Acute Care Nurse Practitioner

The acute care nurse practitioner graduate nursing specialty prepares students for advanced practice positions as nurse practitioners in cardiovascular 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, Family, and Adult-Geriatric 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 adult, family, or adult-geriatric nurse practitioners and are uniquely prepared to provide primary care to populations across the 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 when graduation requirements are met.

Admission Requirements for Nurse Practitioner Master’s Programs

An introductory course in statistics 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.

All applicants for admission must submit the following to the Office of Admissions, School of Nursing:

- a completed application for admission
- a professional statement, resume/CV, and writing sample (AMPNN requires only the statement and resume/CV)
- two favorable references which address professional and/or academic ability
- official transcripts of all previous college-level academic work and evidence of cumulative 3.0 GPA preferred.

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.

Master of Science—Leadership in Health Care Systems

The Leadership Program is an interprofessional platform intended 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 three concentrations: (1) Health Management and Leadership; (2) Clinical Research Coordination (not currently accepting applications); (3) Clinical Nurse Leader (CNL — open to RNs only). Thirty (30) to 37 credits of academic coursework are needed for graduation, depending on the program.

Modeled after executive business programs, the core didactic content reflects competencies essential for health care leaders in the twenty-first century. The content in the three concentrations reflects specialty knowledge and competencies. Progression through the program builds a foundation for the final leadership capstone project. For this, students are placed with a health care executive to experience real world issues, refine their leadership skills, and complete a capstone project.

Admission Requirements for MS in Leadership in Health Care Systems Programs
1. Completion of a Bachelor of Science degree from an accredited college or university. For CNL, degree must be in nursing from an accredited school. CNL applicants also need current RN licensure within the United States or a U.S. territory.
2. Cumulative GPA of 3.0 preferred on a 4.0 scale 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. CNL applicants’ letters of reference (one from an immediate supervisor) should address clinical expertise and leadership talent.
6. Personal interview(s) with LHCS program faculty members.
7. Additional CNL requirements—Clinical practice exemplar relating to patient care (which describes what happened, the intent and the outcomes of actions and interactions with other members of the health care team), and a minimum of three years of employment as a registered nurse in a clinical setting.

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.

**CORE AND CLINICAL CORE COURSES**

400. Research Principles for Evidence-Based Advanced Practice
Credit—five hours
This course is designed to prepare advanced practice nurses in applying evidence to practice and using evidence to drive clinical decision making. Students learn the foundations of research methods that underlie evidence-based practice. The course focuses on developing clinical questions, analyzing clinical data, evaluating pertinent research, and developing practice recommendations. Students explore outcomes in the contexts of professional practice and population management. Students gain a greater appreciation of how theory and practice articulate and how best to apply theory to a clinical problem.

401. The Writing Workshop
Credit—one hour
The purpose of this course is to help students gain proficiency in writing. It provides graduate students with the essential tools for scholarly writing. Rules of grammar, punctuation, format, and composition are reviewed and practiced. Styles of composition are analyzed and applied in writing exercises. The importance of focused presentation of ideas, and clarity and progression of thought are emphasized.

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.

407. Advanced Physiology and Pathophysiology
Prerequisite: undergraduate anatomy and physiology.
Credit—five hours
A study of those physiologic processes that are a basis for advanced nursing practice. The focus is on regulatory mechanisms that maintain homeostasis. Content is based on theories from physiologic and immunologic research. This course 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.

410. Advanced Health Assessment
Prerequisite: prior health assessment coursework or refresher.
Credit—four hours (adult/geriatric NP) or six hours (FNP) (two of which are 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 assessments are presented. From a functional and developmental base, the course emphasizes
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 are discussed and applied to clinical findings. This course includes laboratory modules for specialty skill instruction.

411. Evaluation and Management of Common Health Problems of Adults
Prerequisites: NUR 407, 410, 419; Pre- or corequisite NUR 400.
Credit—five hours (three didactic, two clinical)
This course focuses on the evaluation and management of manifestations of common health deviations across the adult lifespan in a variety of settings and across cultures. Biopsychosocial and pharmacological concepts are applied in formulating differential diagnoses and management plans. Emphasis is placed on developing the advanced practice role in the context of a comprehensive, interdisciplinary approach. This course builds on the advanced assessment concepts and skills in the synthesis of assessment data in order to develop a comprehensive plan of care including appropriate follow-up.

412. Advanced Pediatric Health Assessment and Care of Well Children and Adolescents
Prerequisite: prior health assessment coursework or 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 develop the necessary expertise to provide primary health care to well children and adolescents. Students gain experience interviewing pediatric clients and their families and providing relevant anticipatory guidance, using age-appropriate techniques. Students 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. Course content supports students’ clinical experience in the provision of primary health care to well infants, children, adolescents, and their families.

413. Family Theoretical Frameworks and Application to Nursing Care of Families
Credit—three hours
Required of all Family Nurse Practitioner students, 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 family nursing.

419. Advanced Pharmacology
Prerequisites: introductory human physiology and pharmacology.
Unit I prerequisite to Unit II.
Credit—three hours
This is an advanced course in pharmacology that includes Unit I—one credit of online course material including interpretation of New York State and federal laws and regulations pertaining to prescribing drugs and record keeping; and Unit II—two credits of pharmacokinetics, pharmacotherapeutics, and clinical decision making in drug management for the advanced practice of nursing.

492. Advanced Clinical Practicum
Credit—variable

493. Comprehensive Examination
Credit—none
A comprehensive examination is required for all master’s students. Successful completion of a comprehensive examination demonstrates students’ abilities to integrate knowledge gained through individual courses into critical thinking and advanced practice. Students enroll and complete the exam during the last semester of their academic coursework.

CLINICAL SPECIALTY COURSES

Acute Care Nurse Practitioner
424. Acute Care Nurse Practitioner I
Prerequisites: NUR 403, 411.
Credit—seven hours (three didactic, four clinical)
This course is the first in a two-course specialty sequence for Acute Care Nurse Practitioner students. It is designed to build on the concepts of advanced health assessment and the diagnosis and management of common problems in adults. Emphasis is placed on content-specific to the specialty areas of critical care, cardiovascular care. Content addressing theory and research is presented that (1) crosses areas of specialization, and (2) is focused within each of the two specialty populations. Both direct patient care and systems-oriented, advanced practice skills are included. Case examples and clinical experiences are provided in which students are expected to begin to implement the role of ACNPs with specialty populations across settings.

425. Acute Care Nurse Practitioner II
Prerequisites: NUR 424.
Credit—10 hours (four didactic, six clinical)
This course is the second in a two-course sequence for ACNP students. It is designed to prepare students for advanced practice in the care of acutely ill specialty patients and their families. The course builds on the content from ACNP I. Emphasis is placed on the development of both direct patient care and systems support components of the advanced practice role. A major focus is on the development of leadership abilities within health care systems and interdisciplinary teams. Critical appraisal of how advanced practice nurses affect patient care delivery and health care practices at the institutional, local, and national level is undertaken. Content addressing theory and
research is presented that (1) crosses areas of specialization, and (2) is focused within each of the two specialty populations (critical care and cardiovascular). Case examples and clinical experiences are provided that allow students to become increasingly independent in their own clinical practice with respect to critical thinking and problem solving. Emphasis in role development is placed on effecting change and integration of the multiple roles for advanced practice nurses in an interdisciplinary, integrated health system.

**Pediatric Nurse Practitioner**

**430. Advanced Practicum in the Care of the High-Risk Neonate I**
**Prerequisites:** NUR 407, 412, 419, 436.  
**Credit**—three hours clinical practicum  
Required practicum for those enrolled in the Pediatric Nurse Practitioner/Neonatal Nurse Practitioner specialty.

**431. Advanced Practicum in the Care of the High-Risk Neonate II**
**Prerequisite:** NUR 430.  
**Credit**—three hours clinical practicum  
Required practicum for those enrolled in the Pediatric Nurse Practitioner/Neonatal Nurse Practitioner specialty.

**432. Care of the Neonate and Infants I**
**Credit**—one to three hours  
(Required for post-master’s NNP)

**433. Care of the Neonate and Infants II**
**Credit**—one to five hours  
(Required for post-master’s NNP)

**435. Advanced Concepts in Child and Adolescent Development**
**Prerequisite:** undergraduate course in human development.  
**Credit**—three hours  
This is an advanced course in child and adolescent development for those individuals who desire to gain greater knowledge and depth in the complex issues surrounding human development. Major theories of child development provide a framework for the presentation of physical, cognitive, social, and emotional development from conception through adolescence. Factors influencing growth and development are highlighted. Discussions of classic and current studies as they relate to human development are integrated throughout the course. Emphasis is placed on developmental assessment and intervention for health care providers. Course content also includes management strategies for common behavioral problems encountered at various stages of development.

**436. Nursing Care of the High-Risk Neonate**
**Prerequisites:** NUR 407A, 412, or permission of instructor.  
**Credit**—three hours  
This course provides didactic content in the nursing care of high-risk neonates. Course emphases are on assessment and intervention strategies for infants requiring intensive care. The course also addresses content necessary to deliver comprehensive indirect care for this population of infants, such as discharge planning and provisions for follow-up care.

**437. Pediatric Primary Care I**
**Prerequisites:** NUR 412, 407 for PNP students; NUR 410, 407 for FNP students.  
**Pre- or corequisites:** NUR 400, 403.  
**Credit**—seven hours for PNP students (two clinical), four hours for FNP students  
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 is 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 is guided by a variety of theoretical and empirical perspectives relevant to clinical practice. Students develop physical and psychosocial assessment and intervention skills specific to the pediatric population, using a diagnostic reasoning process. Clinical practice sites include a variety of primary care settings.

**438. Pediatric Primary Care II**
**Prerequisites:** NUR 419, 437, and for students in the neonatal track, NUR 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: beginning development of leadership and health management skills, and 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.

**439. Pediatric Primary Care III**
**Prerequisite:** 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.
Adult Nurse Practitioner, Family Nurse Practitioner, and Adult-Gerontological Nurse Practitioner

444. Primary Health Care I
Prerequisites: NUR 411, 413 (pre- or corequisite for FNP students); pre- or corequisite NUR 403.
Credit—six hours (two didactic, four clinical)
Clinical experience, seminars, topical discussions, and case examples provide an opportunity for synthesis and integration in all aspects of primary care nursing. New content relating to the natural history of health and disease within families over time is included. Students broaden their perspective of the health care provider role in developing the competence and confidence of professional colleague, advanced clinician, consultant, and leader. Providing primary health care to a specific consumer population over an extended period allows the student to assume and share responsibility and accountability in dealing with broad ongoing consumer health care needs as they occur in the family environment.

445. Primary Health Care II
Prerequisite: NUR 444.
Credit—seven hours (two didactic, one role, four clinical)
This course is a continuation of NUR 444, with seminars, clinical topic discussions, case examples, and clinical practicum. Special emphasis is placed on leadership, teaching, and research in the larger community, and on the evaluation of health care services. Emphasis in role development is placed on effecting change and integration of the multiple roles for advanced practice nurses in an interdisciplinary, integrated health system.

447. Interdisciplinary Care of the Older Adult
Prerequisite: NUR 403; pre- or corequisite NUR 411.
Credit—five hours (three didactic, two clinical)
The focus of the course is on interdisciplinary care of older adults across the health care continuum. The unique dynamics of geriatric care are explored within the context of the normal aging process. The course includes psychological and sociological, cultural, and developmental issues of older adults. The unique challenges of aging, including financial challenges, are explored. Foundational information necessary for the identification of health needs of older adults is considered. Best practice initiatives are applied in the clinical setting.

448. Evaluation and Care of the Older Adult
Prerequisite: NUR 403; pre- or corequisite NUR 411.
Credit—six hours (four three didactic and two three clinical)
The focus of this course is on health (including mental health) issues of older adults with emphasis on presentation of illness, diagnostic testing, differential diagnosis, and formulation of a comprehensive management plan. The biopsychosocial model is used as a framework to discuss geriatric syndromes and complex, chronic illness in older adults. Appropriate geropharmacological and non-pharmacological treatment options (including procedures) are explored. Approaches for comprehensive assessment and evidence-based treatments are highlighted.

449. Women’s Health Care for Primary Care Generalists
Prerequisite: NUR 411.
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.

Psychiatric/Mental Health Nursing

450. Psychopathology and Psychiatric Assessment and Diagnosis through the Lifespan
Prerequisite: NUR 452.
Credit—five hours
This is a foundational course that provides the graduate student with a biopsychosocial framework for the practice of psychiatric mental health nursing. Students develop advanced knowledge of current theories related to the etiology and classification of adult personality development and psychopathology. Personality development is conceptualized as an evolutionary lifespan process arising from the continual interaction of person with environment. Personality patterns are depicted along a continuum ranging from adaptive to maladaptive, and are identified and explored through case examples. Students are able to apply psychological and physical assessment knowledge and skills to determine functional and/or organic causes of alteration in biopsychosocial functioning. They begin to develop a perspective of the role of the advanced practice nurse and develop the initial skills required for this role.

451. Individual Psychotherapies Across the Lifespan
Pre- or corequisites: NUR 450, 455.
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 students’ knowledge of psychosocial development, mental health assessment, and psychopathology. Therapy models, derived from various theoretical frameworks, are applied to case 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.
452. Pathophysiology of Mental Illness and Psychopharmacology across the Lifespan I
Prerequisites: NUR 407, 419.
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 is the first of two courses that 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. Content in this course focuses on common mental health issues across the lifespan (e.g., autism, attention deficit hyperactivity disorder, anxiety, and mood disorders). This course is taught primarily online.

453. Pathophysiology of Mental Illness and Psychopharmacology across the Lifespan II
Prerequisite: NUR 452.
Credit—three hours
Pathophysiology of Mental Illness and Psychopharmacology across the Lifespan II offers an in-depth investigation of the neurobiological basis of major psychiatric illnesses for individuals across the lifespan. This is the second of two courses that 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. Content in this course focuses on more complex mental health issues across the lifespan (e.g., thought disorders, substance abuse, and impulse control disorders). This course is taught primarily online.

454. Group and Family Psychotherapies Across the Lifespan
Prerequisites: NUR 450, 451.
Credit—three hours
This course provides the theoretical basis for the understanding and implementation of group and family psychotherapy. Consumers include the family as client as well as the group and/or family as the context of care for the individual client. Students develop an advanced knowledge of current theories and practice modalities related to the practice of group and family psychotherapy and develop the skills required of a psychiatric nurse practitioner.

455. Theoretical Frameworks of Advanced Psychiatric/Mental Health Nursing Practice
Credit—three hours
This is a foundational course that introduces students to theoretical frameworks that are 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.

456. Practicum in Advanced Family Psychiatric/Mental Health Nurse Practitioner Role I
Prerequisites: NUR 410, 450.
Credit—three clinical hours
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 nurse practitioner through the integration of content across the curriculum. Students apply knowledge of psychopathologies, differentiating normal from abnormal development and psychosocial functioning throughout the lifespan. Culturally sensitive approaches and knowledge of cultural diversity are applied in processes of assessment, differential diagnoses, psychoeducation, 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 incorporate evidence-based resources in evaluating clinical performance and case presentations.

457. Practicum in Advanced Family Psychiatric/Mental Health Nurse Practitioner Role II
Prerequisite: NUR 456.
Credit—four clinical hours
This course provides students with a forum to synthesize knowledge acquired throughout the curriculum and facilitates role and skill development for advanced FPMH nursing practice with individuals across the lifespan and their families. Students build on prior knowledge while using current evidence to apply psychotherapeutic modalities and psychopharmacology in comprehensive treatment planning for individuals across the lifespan. 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.
458. Practicum in Advanced Family Psychiatric/Mental Health Nurse Practitioner Role III
Prerequisite: NUR 457.
Credit—four clinical hours
This course provides students with a forum to synthesize knowledge acquired throughout the curriculum and facilitates role and skill development for 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 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 facilitates 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 463. Driving Change in Complex Organizations
Prerequisite: NLX 470 or permission of instructor.
Credit—five hours
This course focuses on the skills necessary to lead complex organizations and builds upon the practical application of the leadership principles and theories taught in Foundations of Leadership and Organizational Development. Students explore and apply strategies for coaching, team building, and leading change within organizations. Students also learn how to create and deploy strategy to successfully guide high-performing teams in driving change. The course utilizes a highly interactive, mixed-method format that examines concepts and builds skills through team projects, 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 464. Informatics, Process Improvement, and Outcome Measurement
Prerequisite or corequisite: NLX 470, 471, 472, or permission of the instructor.
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.

NLX 465. Leadership Capstone
Prerequisites: NLX 463, 464, 466, 470, 471, 472.
Credit—four or six hours
This project requires the synthesis and application of concepts, tools, and skills learned in the various leadership courses to a real world, executive-level project that will directly benefit an organization and a broader targeted community. Community leaders involved in the health and human service arena will guide the design, implementation, and/or evaluation of projects relevant to their organizations. Students serve as knowledge producers and problem solvers, providing the link between the academic curriculum and leadership practice. For example, the project can take the shape of a quality improvement initiative; conceptualization and development of an innovative new program; health care and/or education reform project; application of new technology to enhance service and care delivery; or an in-depth analysis of a problem with recommendations for change. Faculty members work closely with students and community leaders and serve as a resource for support and consultation on the particular project being undertaken. The field placement component of this course is three credit hours, which is equivalent to 180 clock hours.

NLX 466. Epidemiology and Population Health Research
Credit—three hours
This course represents the research component of the Leadership in Health Care Systems Master’s Program and prepares students with advanced research competencies. The course presents the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs, and services; and 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—five 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, interpersonal, group, and organizational 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 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 team projects, 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. The course includes the Writing Workshop and will help students gain proficiency in writing. It provides graduate students with the essential tools for scholarly writing. Rules of grammar, punctuation, format, and composition are reviewed and practiced. Styles of composition are analyzed and applied in writing exercises. The importance of focused presentation of ideas and clarity and progression of thought are emphasized.

**NLX 471. Trends in Health Economics, Policy, and Regulation**  
*Credit—four hours*

In this course, students examine major developments in the evolution of national health policy, financing, and regulation. 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 financing, access, and utilization. Students explore prominent models of twenty-first-century health care financing and consider the viability of public support of health care delivery. They examine the nature of the country’s current health “crisis” and assess major proposals for crisis abatement.

**NLX 472. Ethics and Public Mission in Contemporary Health Care Systems**  
*Credit—three hours*

In this course, students examine the delivery of health care and wellness services through an integrated delivery system. Emphasis is given to the public mission of health care networks, their constituent organizations, and the flow of populations across system levels. Students examine modes for delivery of health promotion, disease management, and acute care services. They identify access barriers, disparities in health utilization and outcomes, and gaps in service. Students explore critical issues confronting health systems in twenty-first-century society.

**NLX 479. Leadership Colloquium**  
*Prerequisite or corequisite: NLX 463, 464, 466, 470, 471, 472, or permission of the instructor.  
Credit—three hours*

This course serves as an “intellectual forum” in which graduate students explore complexities inherent in organizational leadership. The colloquium features a focal topic each week, selected to highlight leadership challenges encountered in organizational settings. Visiting lecturers, renowned for their outstanding leadership ability, offer prepared commentary on the topic. Lecturers are drawn from the University, corporations, business alliances, health and human service agencies, and Rochester’s legislative delegation. After each colloquium session, students prepare individually written statements of practice principles culled from the discussion. At the end of the semester, students submit a “Compendium of Leadership Principles” in satisfaction of a colloquium requirement.

**NLX 493. Comp Exam**  
*Credit—none*

A comprehensive examination is required for all master’s students. Successful completion of a comprehensive examination demonstrates students’ abilities to integrate knowledge gained through individual courses into critical thinking and advanced practice. Students enroll and complete the exam during the last semester of their academic coursework.

**CLINICAL NURSE LEADER TRACK**

**400. Research Principles for Evidence-Based Advanced Practice**  
*Credit—five hours*

This course is designed to prepare advanced practice nurses in applying evidence to practice and using evidence to drive clinical decision making. Students learn the foundations of research methods that underlie evidence-based practice. The course focuses on developing clinical questions, analyzing clinical data, evaluating pertinent research, and developing practice recommendations. Students explore outcomes in the contexts of professional practice and population management. Students gain a greater appreciation of how theory and practice articulate and how best to apply theory to a clinical problem.

**401. The Writing Workshop**  
*Credit—one hour*

The purpose of this course is to help students gain proficiency in writing. It provides graduate students with the essential tools for scholarly writing. Rules of grammar, punctuation, format, and composition are reviewed and practiced. Styles of composition are analyzed and applied in writing exercises. The importance of focused presentation of ideas, and clarity and progression of thought are emphasized.

**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.

**407. Physiological and Pathophysiologica Basis of Advanced Nursing Practice**  
*Prerequisite: undergraduate anatomy and physiology.  
Credit—five hours*

A study of those physiologic processes that are a basis for advanced nursing practice. The focus is on regulatory mechanisms
that maintain homeostasis. 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.

410. Advanced Health Assessment
Prerequisite: prior health assessment coursework or refresher. Credit—four or six hours (two of which are 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 assessments are presented. From a functional and developmental base, the course emphasizes 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 are discussed and applied to clinical findings. This course includes laboratory modules for specialty skill instruction.

419. Advanced Pharmacology
Prerequisites: introductory human physiology and pharmacology. Unit I prerequisite to Unit II.
Credit—three hours
This is an advanced course in pharmacology that includes Unit I—one credit of online course material including interpretation of New York State and federal laws and regulations pertaining to prescribing drugs and record keeping; and Unit II—two credits of pharmacokinetics, pharmacotherapeutics, and clinical decision making in drug management for the advanced practice of nursing.

NLX 464. Informatics, Process Improvement, and Outcome Measurement
Prerequisite or Corequisite: NLX 472, 471, 470 or permission of the instructor.
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.

NLX 465. LHCS Capstone Project
Prerequisites: NUR 403, 407A, 410, 419, NLX 466, 470, 475.
Credit—six hours
This project requires the synthesis and application of concepts, tools, and skills learned in the various leadership courses to a real-world, executive-level project that will directly benefit an organization and a broader targeted community. Community leaders involved in the health and human service arena guide the design, implementation, and/or evaluation of projects relevant to their organizations. Students serve as knowledge producers and problem solvers, providing the link between the academic curriculum and leadership practice. For example, the project can take the shape of a quality improvement initiative; conceptualization and development of an innovative new program; health care and/or education reform project; application of new technology to enhance service and care delivery; or an in-depth analysis of a problem with recommendations for change. Faculty members work closely with students and community leaders and serve as a resource for support and consultation on the particular project being undertaken. The field placement component of this course is four credit hours, which is equivalent to 300 clock hours, which may be across two semesters.

NLX 466. Epidemiology and Population Health Research
Credit—three hours
This course represents the research component of the Leadership in Health Care Systems Master’s Program and prepares students with advanced research competencies. The course presents the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs and services; and 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 475. Leadership in Clinical Nursing
Credit—four hours
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 493. Comp Exam
Credit—none

A comprehensive examination is required for all master’s students. Successful completion of a comprehensive examination demonstrates students’ abilities to integrate knowledge gained through individual courses into critical thinking and advanced practice. Students enroll and complete the exam during the last semester of their academic coursework.

Clinical Research Coordinator Track

NLX 465. Capstone Project
Credit—four hours

This project requires the synthesis and application of concepts, tools, and skills learned in the various leadership courses to a real-world, executive-level project that will directly benefit an organization and a broader targeted community. Students apply knowledge and skill acquired in graduate coursework in implementing, overseeing, administering, and evaluating a clinical research project. Their work is carried out with the guidance of a project preceptor, typically program faculty or other faculty members or an affiliated health organization or industry. These leaders guide the design, implementation, and/or evaluation of projects relevant to their organizations. Students serve as knowledge producers and problem solvers, providing the link between the academic curriculum and leadership practice. For example, the project can take the shape of a quality improvement initiative; conceptualization and development of an innovative new program; health care and/or education reform project; application of new technology to enhance service and care delivery; or an in-depth analysis of a problem with recommendations for change. Faculty members work closely with students and community leaders and serve as a resource for support and consultation on the particular project being undertaken. The field placement component of this course is three credit hours, which is equivalent to fifteen hours for 12 weeks during the spring semester for a total of 180 clock hours.

NLX 466. Epidemiology and Population Health Research
Credit—three hours

This course represents the research component of the Leadership in Health Care Systems Master’s Program and prepares students with advanced research competencies. The course presents the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs and services; and 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 479. Leadership Colloquium
Prerequisite or Corequisite: NLX 466, 480, 481, 482, 483, 484, or permission of the instructor.
Credit—three hours

This course serves as an “intellectual forum” in which graduate students explore complexities inherent in organizational leadership. The colloquium features a focal topic each week, selected to highlight leadership challenges encountered in organizational settings. Visiting lecturers, renowned for their outstanding leadership ability, offer prepared commentary on the topic. Lecturers are drawn from the University, corporations, business alliances, health and human service agencies, and Rochester’s legislative delegation. After each colloquium session, students prepare individually written statements of practice principles culled from the discussion. At the end of the semester, students submit a “Compendium of Leadership Principles” in satisfaction of a colloquium requirement.

NLX 480. Clinical and Translational Research Design
Credit—four hours

This course prepares clinical research coordinators to successfully implement and manage a range of clinical and translational research designs. Requirements and design elements of research projects are reviewed within the context of scientific rigor, study integrity, and internal validity. Randomized clinical trials, a variety of quasi-experimental designs, cohort (prospective and retrospective), factorial, crossover, case-control, and other selected designs are reviewed. In addition, community participatory research and translational models are examined. Research reporting guidelines for these study designs (e.g., CONSORT statement for RCTs) are also covered. Simple statistical methods associated with the various research designs are reviewed.

NLX 481. Ethical Foundations and Issues in Human Subject Research
Credit—three hours

This course addresses sampling, recruitment, and follow-up procedures, as well as the protection of human subjects. Content includes preparation and implementation of enrollment protocols, subject eligibility and screening, vulnerable subjects, voluntary informed consent, Institutional Review Board (IRB) regulations, submission and approval, ICH good clinical practice (GCP) guidelines, adverse event monitoring and reporting, NCI data safety and monitoring guidelines and study termination rules. Related topics in bioethics are addressed throughout the course, including subject compensation, scientific integrity and misconduct, privacy and confidentiality, conflict of interest, and minority participation in research.

NLX 482. Product Development in the Pharmaceutical, Device, and Biologics Industry
Credit—four hours

Students focus on the process and skill dimensions of successful leader interventions. This course focuses on the process by which drugs, devices, biologics, and medical procedures are conceived,
developed, and tested in clinical trials. The role of industry in facilitating clinical research is considered. Content incorporates a range of protocols including pharmacological, surgical, clinical, and biomedical interventions. Pertinent topics include intervention development, manual writing, administration, quality control, fidelity, dosage and dose-finding, adverse effects monitoring, inventory control treatment compliance and adherence, placebo effects, drop-out and ITT protocol, and clinical practice and monitoring. Intervention administration, monitoring, and regulatory policy, including FDA guidelines are discussed. Various intervention delivery settings are explored including hospitals, clinics, chronic care facilities, home visits, and communities.

**NLX 483. Research Project Management in Complex Health Care Systems**  
*Credit—five hours*

This course provides knowledge and skills to manage all phases of research projects, including project start-up, protocol development, standard operating procedures, documentation, workflow, staff hiring, training and supervision, budget and expenditures, contract management, regulatory guidelines, and project close-out. The course covers the structure and interactions among academic, corporate, government, and community organizations involved in research, as well as multisite project management. Translation of clinical research to patients and communities and leadership skills are also addressed.

**NLX 484. Research Data Collection and Intervention Administration in Clinical Practice**  
*Prerequisite: NLX 482. Credit—four hours*

This course covers intervention administration, monitoring, regulatory policy, and data management in clinical research. A range of intervention protocols is considered but behavioral interventions are highlighted. The development and implementation of interventions including protocol development and administration, quality control, monitoring, and oversight are covered. Data management including sources and methods of data collection, storage, management, and reporting strategies are considered. Database creation and structure, and data warehousing, management, and mining techniques are also explored. Regulations pertaining to personal health information (PHI) protection and confidentiality as required by HIPAA and other regulatory bodies are covered. Simple statistical analyses for data monitoring and reporting are also covered. These topics are considered in the context of the clinical practice setting.

**NLX 493. Comp Exam**  
*Credit—none*

A comprehensive examination is required for all master’s students. Successful completion of a comprehensive examination demonstrates students’ abilities to integrate knowledge gained through individual courses into critical thinking and advanced practice. Students enroll and complete the exam during the last semester of their academic coursework.

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**DNP PROGRAM**

464. Informatics, Process Improvement, and Outcome Measurement  
*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.

466. Epidemiology and Population Health Research  
*Credit—three hours*

This course represents the research component of the Leadership in Health Care Systems Master’s Program and prepares students with advanced research competencies. The course presents the theoretical, methodological, and statistical concepts used in the development and evaluation of population-based health research, programs and services; and 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 471. Trends in Health Economics, Policy, and Regulation**  
*Credit—four hours*

In this course, students examine major developments in the evolution of national health policy, financing, and regulation. 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 financing, access, and utilization. Students explore prominent models of twenty-first-century health care financing and consider the viability of public support of health care delivery. They examine the nature of the country’s current health “crisis” and assess major proposals for crisis abatement.

472. Ethics and Public Mission in Contemporary Health Care Systems  
*Credit—three hours*

In this course, students examine the delivery of health care and wellness services through an integrated delivery system.
Emphasis is given to the public mission of health care networks, their constituent organizations, and the flow of populations across system levels. Students examine modes for delivery of health promotion, disease management, and acute care services. They identify access barriers, disparities in health utilization and outcomes, and gaps in service. Students explore critical issues confronting health systems in twenty-first-century society.

480. Clinical and Translational Research Design
Prerequisite: NUR 510.
Credit—four hours
This course prepares clinical research coordinators to successfully implement and manage a range of clinical and translational research designs. Requirements and design elements of research projects are reviewed within the context of scientific rigor, study integrity, and internal validity. Randomized clinical trials, a variety of quasi-experimental designs, cohort (prospective and retrospective), factorial, crossover, case-control, and other selected designs are reviewed. In addition, community participatory research and translational models are examined. Research reporting guidelines for these study designs (e.g., CONSORT statement for RCTs) are also covered. Simple statistical methods associated with the various research designs are reviewed.

510. General Linear Approaches I
Credit—three hours
This course provides discussion and application of descriptive and inferential statistics, correlation and regression, analysis of variance, nonparametric, and distribution-free statistics.

572. Leading Evidence-Based Practice Initiatives
Credit—three hours
The purpose of this course is to prepare nursing leaders for designing and implementing evidence-based practice initiatives (e.g., performance improvement, clinical research) for purposes of improving the quality of care for patients, populations, and communities in diverse health care settings across the continuum of care. Structures and processes that influence health systems are examined in light of economic, political, and regulatory priorities. Methodologies to implement evidence-based initiatives are analyzed and strategies to sustain success are explored for their usefulness across the continuum of care. The responsibility of the DNP-prepared nurse to use evidence-based initiatives in affecting public policy is investigated.

574. Strategic Planning and Evaluation of Hospital Health Care Delivery Systems
Prerequisite: NUR 480.
Credit—three hours
This course provides students with the skills necessary for measuring and monitoring outcomes of individuals and organizations within diverse health care systems. Administrative, organizational, systems, and evaluation theories are examined for application to health care strategic planning and decision-making activities. Applied research and theory-derived evaluation methods are used to explore student-identified questions of relevance to health delivery systems.

582. DNP Practicum I
Prerequisites: NUR 574 and 480.
Credit—three hours (two clinical hours)
This course provides students with learning experiences in a variety of clinical settings tailored to the student’s identified area of specialization. Such experiences are intended to support students in the analysis, application, and evaluation of knowledge gained through foundational DNP coursework in clinical practice. Biweekly faculty-led seminars are designed to assist students to reflect on best practice approaches and their consequences and generate solutions for creatively dealing with barriers that interfere with the delivery of equitable, evidence-based, patient-centered care.

585. DNP Practicum II
Prerequisite: NUR 584.
Credit—three hours (two clinical hours)
This course builds on the DNP Practicum I by continuing to provide students with learning experiences in a variety of clinical settings tailored to the student’s identified area of specialization. The application and integration of knowledge gained through foundational DNP coursework continues with emphasis on the use of information systems and technology to support and improve health care system functioning and care delivery. Biweekly faculty-led seminars are designed to assist students to reflect on best practice approaches and their consequences and generate solutions for creatively dealing with barriers that interfere with the delivery of equitable, evidence-based, patient-centered care.

586. DNP Policy Practicum
Prerequisite: NUR 584, 585.
Credit—three (two clinical) hours
Building on course content, this practicum provides students with direct exposure to public and private sector roles in health policy development and experience advising policy makers about health care issues.
587. DNP Residency and Capstone Project
Prerequisite: NUR 584, 585, 586.
Credit—ten hours (three–six clinical hours)

Building upon prior practicum experiences, the DNP residency is an end-of-program practice immersion experience to foster continued knowledge assimilation for advanced specialty practice at a high degree of complexity. Biweekly faculty-led seminars are designed to assist students to reflect on best practice approaches and their consequences and generate solutions for creatively dealing with barriers that interfere with the delivery of equitable, evidence-based, patient-centered care. Independent work with a mentor culminates in completion of the DNP Capstone Project.

PHD PROGRAM

505. Epistemology and Concept Development
Credit—three hours

This course examines the 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 apply the process of concept development to a specific area of interest.

506. Epistemology and Theory Construction
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. The process of theory construction is examined from logical, inductive and deductive approaches. The interrelationships between concepts, constructs, and variables are explicated for considering how study designs are generated. Students apply knowledge gained about the process of theory construction to a specific area of interest.

507. Research Appraisal and Synthesis
Credit—three hours

This course is designed to review existing programs of research among faculty and in the research literature, and to provide practice in collecting, appraising, and synthesizing published research evidence in an area of student interest. In both activities, students consider the relationships between theory and research and between research questions and study designs.

508. Writing and Publishing in the Health Sciences
Credit—two hours

The primary focus of this course is to prepare students to successfully disseminate research findings in the form of published articles in peer-reviewed scientific journals. This course provides students with both scholarly and practical knowledge on writing and publishing scientific manuscripts. It covers the publishing process, as well as techniques for writing clear and well-organized manuscripts, and ethical issues involving manuscript preparation and publication.

510. General Linear Approaches I
Credit—three hours

This course provides discussion and application of descriptive and inferential statistics, correlation and regression, analysis of variance, nonparametric, and distribution-free statistics.

511. Basic Quantitative Methods
Credit—three hours

This course covers basic principles of 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. Attention will be given to formulation of research questions and hypotheses, sampling design, control and comparison groups, stratification and factorial designs, survey 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.

512. General Linear Approaches II
Credit—three hours

This course presents 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 behavioral science questions. Building on General Linear Analysis I, topics include multiple regression, structural equations, logistic analyses, and multivariate techniques. The emphasis is practical, with a focus on the analysis of actual data.

513. Research Measurement
Credit—three hours

The emphasis of the course is on the principles of measurement and their application to problems in health research. The course addresses (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.

514. Research Integration and Proposal Development
Credit—three hours

The course provides students an opportunity to integrate material from courses in cognate areas, research methods, statistics, and clinical nursing 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.

517. Teaching and Learning in Nursing
Credit—three hours
The course provides an introduction to the principles of teaching and evaluation strategies. The course discusses educational theories, teaching strategies, learning activities, and evaluation strategies.

531. Seminar in Theories that Guide Research in High-Risk Children and Youth
Credit—three hours
This graduate-level seminar for PhD students and postdoctoral fellows focuses on discussion and integration of theories that guide clinical research at the individual, family, and community levels and are directly applicable to research of children, youth, and families. Human Ecology Theory is the overarching theory for the seminar. There is emphasis on other theories that assist researchers in developing models and focus interventions in order to prevent and ameliorate threats to child and family health. Individual level theories include coping and self-regulation, self-efficacy, behavior change (value expectancy), resilience, cognitive representation, and self-agency theories. Family level theories include relationship, attachment, separation/individuation, and peer/family theories. Community-level theories include organizational systems change, community and environmental and cultural effect theories. Seminar material is discussed in the context of the ongoing research programs of faculty who are using these theories to guide their own research.

532. Advanced Seminar in Intervention Research for High-Risk Children and Youth
Credit—three hours
Seminar for all PhD students and postdoctoral fellows focuses on discussion and integration of theories that guide clinical research at the individual, family, and community levels and are directly applicable to research of children, youth, and families. Models of individual, interpersonal, and social health behavior and behavior change are discussed, and the underlying mechanisms for health disparities are considered, in the context of faculty and student research interests.

544. Advanced Biostatistics
Credit—three hours
This course provides an introduction to advanced biostatistical techniques and their applications to data. The course covers structural equation modeling, multilevel modeling, missing data imputation, and survival analysis. Other topics may be included, depending on interests. Students are encouraged to bring their own research data into the class to be used as examples and are guided to design and analyze the data for report writing and verbal presentation.

545. Research Using Existing Data
Credit—three hours
The goal of the course is to learn to evaluate existing data, conduct data analysis using a large dataset, and understand issues in developing research programs using existing data. The topics and issues examined include sources and advantages and disadvantages of existing data, the process of obtaining data, appraisal and use of existing data, and conceptual, methodological, and statistical considerations. Statistical methods including multilevel modeling and analysis of complex survey data are also introduced.

555. Basic Qualitative Methods
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 approaches 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 representing the three major traditions of ethnography, grounded theory, and phenomenology.

556. Advanced Qualitative Research Methods: Qualitative Description and Content Analysis
Credit—three hours
This course builds on prior coursework in or equivalent to NUR 555, an overview and introduction to basic qualitative methods. This advanced course extends foundational knowledge by enabling learners to examine in depth qualitative descriptive design and the analytic technique of content analysis and apply these to their own practice-related research. Qualitative description is the most commonly used approach to qualitative research but has only recently been labeled and described. The origins and historical and philosophical placement of qualitative description are explored. Processes and strategies for research question development, data collection, and data analysis are examined and practiced. Specific technical issues related to the definition of the research problem, sample selection, data gathering, analysis,
interpretation, and reporting are experienced by the learner through hands-on involvement in a student-defined research project.

560. Role of the Clinical Researcher
Credit—none
Drawing on presentations from researchers in the School of Nursing, students are provided with the opportunity to consider their future career trajectories. Presenters discuss the interplay between clinical practice questions and the research approaches being used to address these knowledge needs. Presentations are designed also to help students conceptualize their own research questions, driven by their “need to know” in order to provide evidence-based care.

590. Dissertation Workshop
Credit—none
The purpose of the Dissertation Workshop is to help students who have completed their coursework sustain momentum toward proposal defense and completion of 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, e.g., examining issues of research ethics, research design, responding to evaluations of applications for funding (“pink sheets”), and working with an interdisciplinary team.

591. PhD Reading Course
Credit to be arranged (usually not to exceed three hours)

595. Research for Doctoral Dissertation
Credit to be arranged

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
William E. Simon Graduate School of Business Administration

Administrative Officers

Andrew Ainslie, PhD
Dean

Ronald L. Goertler, PhD
Senior Associate Dean for Faculty and Research, Professor of Computers and Information Systems

Ronald W. Hansen, PhD
Senior Associate Dean for Program Development, William H. Meckling Professor of Business Administration, and Director of the Bradley Policy Research Center

PhD Committee

The PhD Committee is composed of faculty from the various concentration areas and is currently chaired by Ron Kaniel.

Faculty

--- Professor ---

James A. Brickley, PhD (Oregon)
Gleason Professor of Business Administration and Professor of Economics and Management and of Finance

Delores Conway, PhD (Stanford)
Professor of Statistics and Real Estate Economics

Rajiv M. Dewan, PhD (Rochester)
Professor of Computers and Information Systems

Marshall Freimer, PhD (Harvard)
Professor of Management Science and of Computers and Information Systems (retired)

J. William Gavett, PhD (Cornell)
Professor Emeritus of Operations Management

Dan Horsky, PhD (Purdue)
Benjamin L. Forman Professor of Marketing

Thomas H. Jackson, JD (Yale)
Distinguished University Professor and President Emeritus

Gregg A. Jarrell, PhD (Chicago)
Professor of Finance and Economics

Ron Kaniel, PhD (University of Pennsylvania)
Jay S. and Jeanne P. Benet Professor and Professor of Finance

John B. Long, Jr., PhD (Carnegie Mellon)
Frontier Communications/Rochester Telephone Professor of Business Administration and Professor of Finance and Economics

Duncan T. Moore, PhD (Rochester)
Vice Provost for Entrepreneurship, Rudolf and Hilda Kingslake Professor of Optical Engineering, Professor of Biomedical Engineering and of Business Administration

Robert Novy-Marx, PhD (California, Berkeley)
Lori and Alan S. Zekelman Professor and Professor of Finance

G. William Schwert, PhD (Chicago)
Distinguished University Professor and Professor of Finance and Statistics

Abraham Seidmann, PhD (Texas Tech)
Xerox Professor of Computers and Information Systems and Operations Management

Joel Seligman, JD (Harvard)
President, University of Rochester

Greg Shaffer, PhD (Princeton)
Wesray Professor of Business Administration and Professor of Economics and Management and of Marketing

Joanna Shuang Wu, PhD (Tulane)
Evans Y. and Susanna Lam Professor and Professor of Accounting

Clifford W. Smith, Jr., PhD (North Carolina)
Louise and Henry Epstein Professor of Business Administration and Professor of Finance and Economics

Jerold B. Warner, PhD (Chicago)
Fred H. Goven Professor of Business Administration and Professor of Finance

Toni M. Whited, PhD (Princeton)
Michael and Diane Jones Professor of Business Administration and Professor of Finance

Jerold L. Zimmerman, PhD (California, Berkeley)
Ronald L. Bittner Professor of Business Administration and Professor of Accounting

Mark Zupan, PhD (MIT)
Professor of Economics and of Public Policy
ASSOCIATE PROFESSOR

Gregory C. Dobson, PhD (Stanford)
Associate Professor of Operations Management

Paul Ellickson, PhD (MIT)
Associate Professor of Economics and of Marketing

Harry Groenevelt, PhD (Columbia)
Associate Professor of Operations Management

Phillip J. Lederer, PhD (Northwestern)
Associate Professor of Operations Management

Mitchell J. Lovett, PhD (Duke)
Associate Professor of Marketing

Sudarshan Jayaraman, PhD (North Carolina, Chapel Hill)
Associate Professor of Accounting

Michael A. Raith, PhD (London School of Economics and Political Science)
Associate Professor of Economics and Management

Tolga Tezcan, PhD (Georgia Tech.)
Associate Professor of Operations Management

Vera Tilson, PhD (Case Western Reserve University)
Associate Professor of Operations Management

Gerard J. Wedig, PhD (Harvard)
Associate Professor of Business Administration

Ravi Mantena, PhD (New York University)
Clinical Associate Professor of Computers and Information Systems

Paul E. Nelson, PhD (Rochester)
Clinical Professor of Marketing

Werner Schenk, MBA (Rochester)
Clinical Assistant Professor of Computers and Information Systems

Ronald M. Schmidt, MA (Ohio State)
Janice M. and Joseph T. Willett Professor of Business Administration for Teaching and Service and Clinical Professor of Economics and Management

Heidi Tribunella, MS (SUNY Institute of Technology)
Clinical Associate Professor of Accounting

Charles E. Wasley, PhD (University of Iowa)
Joseph and Janice Willett Distinguished Scholar and Clinical Professor of Accounting

Kurt Wojdat, PhD (University of Buffalo)
Clinical Assistant Professor of Accounting

Ellen Zuroski, MS (Rochester)
Clinical Assistant Professor of Business Communications

EXECUTIVE PROFESSOR

George R. Cook, MBA (Ohio State University)
Executive Professor of Business Administration

Richard Couch, MBA (Rochester)
Executive Professor of Business Administration

Dennis Kessler, MSL (Yale)
Executive Professor of Business Administration

Lawrence J. Matteson, MBA (Rochester)
Executive Professor of Business Administration

David J. Oliveiri, MBA (Rochester)
Executive Professor of Business Administration

LECTURER

Daniel J. Burnside, PhD (Cornell)
Lecturer in Finance

Barry A. Friedman, PhD (Ohio State)
Lecturer in Economics and Management

W. Barry Gilbert, MBA (Rochester)
Executive Lecturer in Business Administration and E-Commerce

Paul F. Shanahan, JD (Albany)
Lecturer in Business Law

Frank Torchio, MBA (Rochester)
Lecturer in Finance and Economics

Mark Wilson, MS (RPI)
Lecturer in Entrepreneurship

CLINICAL FACULTY

Ronald W. Hansen, PhD (Chicago)
William H. Dieckling Professor of Business Administration and Clinical Professor of Business Administration

Glenn Huels, MBA (Rochester Institute of Technology)
Clinical Associate Professor of Business Administration

Roy Jones, PhD (Stanford)
Clinical Assistant Professor of Computers and Information Systems
Perspective

The William E. Simon Graduate School of Business Administration has a faculty of 68, including individuals specifically trained in the functional areas of accounting, competitive and organizational strategy, finance, computers and information systems, health sciences, marketing, e-commerce, and operations management, as well as attorneys, economists, mathematicians, and statisticians.

Five key components make the Simon School one of the world's top business schools, and together contribute to our success in developing tomorrow's leaders.

1. Over four decades, the Simon School's world-class faculty have made enormous contributions that have revolutionized the kinds of questions asked in business and changed how countless companies and executives in the United States and abroad conduct business. Our economics-based approach to problem solving and the way faculty integrate topics in our cross-functional curriculum are distinguishing features of the School.

2. Admission is highly competitive. We strive to have selectivity as well as diversity.

3. The Simon School maintains its small size. We enroll just over 900 students in the full- and part-time and executive MBA, MS, and PhD programs.

4. The Simon School stresses preparation for a lifetime of work in business—analytical skills, thinking across functions, understanding what motivates people, working effectively on teams, and developing management communication skills.

5. At the Simon School, opportunities to lead others are extremely varied.

Master of Business Administration Program

Program of Study

To earn the MBA degree, 67 credit hours of study (64 credit hours for part-time study) with a 3.0 grade point average must be completed. The MBA program normally involves six quarters of full-time study, but exceptional students are able to complete it in a shorter period. All MBA students have the option of taking a 21st and 22nd course free of charge within a year of completing the program.

The MBA curriculum consists of nine required core courses, 11 electives, and a management communication sequence taken over three quarters (full-time students only). Although students are not required to complete a concentration, most opt for at least one, and in many cases two. Concentrations permit students to develop expertise in specific areas.

For more information about the Simon School's MBA program, please visit us online at www.simon.rochester.edu/.

Master of Science in Business Administration, Master of Science in Finance, and Master of Science in Accountancy

The master's degree program offers six concentrations: manufacturing management, service management, information systems management, general management, marketing, and medical management.

The Simon School also offers the Master of Science in finance and the Master of Science in accountancy programs.

The manufacturing and service management programs provide management training for individuals who wish to remain in those areas. They can help operations managers and industrial or manufacturing engineers gain further expertise in operations management and stay current with the most recent developments in the field. Designed for individuals involved in operations, in manufacturing, or in service firms, these programs are more technical than the general MBA degree and may be earned by someone who already has an MBA without an operations management concentration. These programs require 39 credit hours of study.

The information systems management program is appropriate for professionals who are committed to careers in information systems and who need management expertise. The program emphasizes both management principles and an understanding of the modern technical aspects of information systems, which facilitate the integration of information systems into an organization. This program requires 19 credit hours of study.

The MS degree with a concentration in general management is designed for individuals whose careers would be enhanced by learning the foundations of successful management. The program requires completion of 12 classes. Nine of these are required core classes that cover the principles of finance, accounting, marketing, operations, information systems, managerial economics, and data-driven managerial decision making. The three remaining classes are electives that students can choose according to their interests. A student pursuing the MS degree with a concentration in general management on a full-time basis completes the program in four quarters. A variety of part-time scheduling opportunities is possible.

The MS in business administration in marketing 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 main emphases: advertising, marketing research, and sales. The ideal candidate for the Simon School MS program is someone with high energy who is excited about the prospect of learning advanced skills in a compact time frame and subsequently pursuing a successful marketing career. Applicants should have taken some mathematics and/or statistics as undergraduates and be ready for advanced statistical training in the program.

The MS in business administration in medical management's objective is to provide physicians and medical professionals with management tools to enable them to independently manage their health care organizations. The part-time medical management master's program is specifically designed to accommodate the busy schedules of physicians and other medical professionals. The program can be completed in one calendar year, with an in-class time commitment of one night per week and one weekend per month (with, of course, additional preparation and work outside of class). Full-time study is offered for recent undergraduates who are seeking professional roles in a health sector organization.
Master of Science in Finance

The MS in finance degree is available as follows:

Students who have already earned an MBA with a general management or non-finance focus and need additional training in the finance area and/or are considering a career change.

Students with a completed bachelor degree and a demonstrated quantitative aptitude. There are two additional graduate courses required for students who do not already hold an MBA degree.

The degree is offered on a full-time or part-time basis and classes are taught by faculty internationally known for financial expertise. Full-time students complete the program in 9 to 11 months depending on whether the candidate already holds an MBA degree.

Master of Science in Accountancy

The Master of Science in accountancy program is designed for students seeking to pursue Certified Public Accounting (CPA) licensure. New York State, as well as most other states, has adopted a 150-credit-hour educational requirement, which can be satisfied with a combination of undergraduate and graduate courses. The MS in accountancy program can be completed in one academic year of full-time study. It is also offered on a part-time basis.

For more information about the Simon School's MS programs, visit us online at www.simon.rochester.edu/.

Executive MBA Programs

The mission of the Simon School's Executive MBA program is to maximize the benefits of a general management MBA for mid-career professionals. This program consists of two academic years of intensive MBA classes. Classes are offered on a Friday–Saturday schedule so that students may continue to work full time. The integrated sequence of courses leads to a fully accredited Master of Business Administration from the University of Rochester. An executive MBA program has been established with a European partner institution. Designed for European managers, the program consists of 18 months of study, including a summer term in Rochester. The course of study is equivalent to the Rochester executive program and is taught by Simon School faculty along with European scholars.

Admission to the Executive MBA Program is based on application and interview.

For additional information or to request a catalog and application, please visit us online at www.simon.rochester.edu/emba.

Joint Degree Programs

MBA-MPH

The Simon School offers a three-year program in conjunction with the School of Medicine and Dentistry. Courses are taken both at the Simon School and at the Medical Center in the Department of Community and Preventive Medicine. For further information, consult the current issue of the Simon School Information Guide or contact the MBA/MS Admissions Office at the Simon School.

MD-MBA

The Simon School, in conjunction with the University's School of Medicine and Dentistry, offers a five-year program in which students can earn both the Master of Business Administration and the Doctor of Medicine degrees. Interested students may obtain more information from the Office of the Associate Dean at the Medical School or the MBA/MS Admissions Office at the Simon School.

For more information, visit us online at www.simon.rochester.edu/.

PhD Program

The Simon School offers a PhD program for students who are interested in research and teaching careers. The program is highly analytical in its orientation and, while real-world applications are emphasized, students receive substantial training in theory and quantitative methods. Program graduates have excellent employment opportunities in academe and other research institutions.

All students start with the first year, called the core, building a firm foundation of mathematics, statistics, and economics. While the majority of the courses are taken in common by all the incoming students, there is some specialization. This specialization becomes more intense in the second year when the students concentrate on their major and minor fields of study. The "core" exams, given in June of the first year, serve as a key for early assessment and are based solely on the material covered in the core courses. They are designed to determine whether the student has learned enough of the basic material to make continuation in the program advisable.

A first-year research paper is required in the fall of the second year. This paper is designed to get students thinking about research early in their academic careers, which enhances the process of choosing a thesis topic.

During the second year of the program, students concentrate their study in two chosen fields of specialization, a major and a minor. The fields offered are accounting, applied economics, applied statistics, competitive and organizational strategy, computers and information systems, finance, macroeconomics, management science, marketing, and operations management. Most fields are defined by the material covered in seven to nine advanced courses and most students choose to take these courses. Qualifying examinations in these fields are given in the summer and fall following the second year of study, and students complete work on an original research paper, which also must be presented by the fall of the third year.

Early in the third year, students are evaluated for admission to candidacy. The candidacy decision involves an evaluation of the students' overall academic performance. Recommendations for admission to candidacy by the faculty in the students' major area imply a willingness to supervise their dissertations. At this point, students move on to their research for the dissertation.

When students have made enough progress on the thesis to define the problem and to state how the remainder of the research will proceed, a thesis proposal seminar is scheduled. In this seminar, students describe future research plans to interested faculty and to other PhD candidates. The faculty then evaluate the proposal and decide whether or not it is acceptable. When
the research described in the approved proposal is completed satisfactorily and successfully defended in another seminar, students are awarded the PhD degree.

**PhD Admission and Financial Aid**

No particular undergraduate major is required for admission to the PhD program, but some training in mathematics (at least a year of calculus) is essential. Many students have undergraduate degrees in mathematics, engineering, or economics-based majors. All students are required to spend the months of July and August before their first year honing mathematic and statistical skills in preparation for first-year coursework. Financial aid is available for these two months.

Applicants to the program must take either the Graduate Management Admission Test or the Graduate Record Examination. Their scores on the test, academic records, and letters of recommendation are all considered carefully by the PhD committee.

Most students who are admitted to the program receive financial assistance. In the first year of study, this financial aid is in the form of a fellowship plus a tuition scholarship. The generous fellowship allows first-year students to devote full time to studies. Advanced students typically receive a combination of a fellowship, tuition scholarship, and a teaching or research assistantship.

The application deadline for all applicants is January 15. For more information, see the Simon School website at www.simon.rochester.edu/programs/phd/index.aspx.

### Courses of Graduate Instruction

A complete listing of courses and course descriptions can be found in the current issue of *Simon Management Programs* (MBA or MS) or the EMBA Program catalog, which may be obtained from the Admissions Office, William E. Simon Graduate School of Business Administration, Schlegel Hall, University of Rochester, P.O. Box 270107, Rochester, New York 14627-0107; (585) 275-3533 or (585) 275-2959 (PhD).

All courses under the quarter system carry three hours of credit, unless otherwise indicated. Also, courses offered jointly with the University of Rochester’s Department of Economics or Statistics and the School of Medicine and Dentistry vary in credit hours.

One or two faculty members are visitors from other institutions. Carefully selected Simon School doctoral students teach a small number of graduate courses, typically summer offerings. Such students assume all of the responsibilities of regular faculty instructors. Executives from corporations, as well as local business owners, also serve as an additional faculty resource at the school for selected master’s-level courses.

A course schedule showing offerings, times and instructors for each quarter is available from the Registrar’s Office prior to the start of each quarter.

### Accounting (ACC)

Charles E. Wesley
*Area Coordinator*

**Master’s-Level Courses**

**401. Corporate Financial Accounting**

*Credit—four hours*

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 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. Accounting for Management and Control**

*Prerequisites: ACC 401 and STR 401; 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. (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 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 in increasingly 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)
Prerequisite: BPP 432.

This course is a continuation of 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, 423, and FIN 402.

This course covers the conceptual framework for standard settings established by the Financial Accounting Standards Board (FASB). It also reviews how to research financial accounting and reporting issues using the FASB Accounting Standards Codification. The research of financial accounting and reporting issues
are applied to professional accounting decisions in financial reporting, disclosure, and other accounting decision making. In addition, a comparison of U.S. 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 focuses 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 are developed to research the tax code and IRS rulings to solve tax issues.

438. Auditing II—Auditing and Information Systems
Prerequisites: ACC 401.

This course focuses largely on Sarbanes-Oxley compliance and internal control systems. Internal control systems are covered in depth, with focus on internal controls in an information technology (IT) environment. The IT environment is discussed from the perspectives of designing effective internal controls and auditing in an IT environment. The function of the internal audit department is 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 cost allows the student to understand how costs are reported and how to use this information to make decisions within the health services entity. The following topics are examined within a health services setting: cost allocation, cost-volume-pricing analysis, budgeting and variance analysis, and activity-based costing.

PhD Courses

501. Seminar in Accounting
Credit—one hour. 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 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 is based on the quality of students’ contributions to the pre-seminar meetings as well as their contributions and participation in the actual workshops. (Each quarter)

510. Accounting Research I
Credit—three hours.

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. (Fall quarter)

511. Accounting Research II
Prerequisite: ACC 510.
Credit—three hours.

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. (Winter quarter)
512. Advanced Topics in Accounting Research
Prerequisites: ACC 510 and 511.
Credit—three hours
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. (Spring quarter, alternates with ACC 513)

513. Contemporary Topics in Accounting Research
Prerequisites: ACC 510 and 511.
Credit—three hours
This course covers topics including value relevance, accounting-based valuation models, earnings quality, and 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. (Spring quarter, alternates with ACC 512)

APPLIED ECONOMICS (AEC)

John B. Long Jr.
Area Coordinator

PhD Courses

501. Applied Economics Seminar I
The seminar is a forum for recent and current research. PhD students, faculty, and outside speakers present papers on their current research and/or discuss recent work by others in the field.

502. Applied Economics Seminar II
This course is a continuation of AEC 501.

503. Organizational and Competitive Strategy Seminar
(Same as STR 501)
This course is a continuation of AEC 501 and 502.

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. Primarily for entering doctoral students. (Summer)

505. Mathematical Techniques in Economics
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, and differential and integral calculus. Primarily for entering doctoral students. (Summer)

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
The first of a three-course sequence providing a survey of the substance and methods of contemporary price theory for students preparing to do research. Generally, the first 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 are covered.

512. Advanced Price Theory II
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. 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. While this is a theory course, the instructor also occasionally refers to relevant empirical work.
513. Advanced Price Theory III

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 equilibrium, and perfect Bayesian equilibria are used as needed. Special topics may include contracts, patents, licensing, bundling, tying, buyer-seller networks, switching costs, price discrimination, mergers, and entry barriers. Students read and critique journal articles, and areas for future research are highlighted.

516. Analysis of Economic Policy

This course is offered at the discretion of the instructor.

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. Advanced Empirical Industrial Organization

Empirical Industrial Organization (IO) methods have become an integral element of the applied econometrician's tool kit across many areas. Applications of these methods are not limited to IO but are seen in diverse areas such as political science, labor economics, corporate finance, and marketing. These methods stress combining strong IO theory with cutting-edge econometrics to answer substantive questions. In addition to introducing students to new methods and topics, this course also aims to cultivate a strong research focus in students. It encourages students to read and critically evaluate challenging papers and discuss approaches to improving them. As such, this course is in the best tradition of Simon's research approach.

525. Mathematical Economics I

(Traditionally offered)

Prerequisite: AEC 505.
Credit—four hours

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. (Offered at the discretion of the instructor.)

### APPLIED STATISTICS (APS)

**Rajiv M. Dewan**  
*Area Coordinator*

#### Master's-Level Courses

**425. Advanced Managerial Data Analysis**  
*Prerequisites: GBA 411 and 412.*

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.

#### PhD Courses

**511. Introduction to Mathematical Statistics**  
(Traditionally offered)

This course offers a more theoretical treatment of the subject matter of APS 411. Primarily for entering doctoral students. (Summer)

**514. Introduction to Econometrics**  
*(Same as College course ECO 484)*  
*Prerequisites: AEC 505 or equivalent and APS 511 or equivalent.*  
*Credit—two hours*

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 AS&E course ECO 485)*  
*Prerequisite: APS 514.*  
*Credit—four hours*

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 are also covered. The course assumes familiarity with matrix algebra, probability theory, basic statistics, and econometrics at the level of ECO 483 and ECO 484 and 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 AS&E course ECO 517).
Prerequisite: APS 515.
Credit—five hours
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 AS&E course ECO 518)
Prerequisite: APS 523 or permission of the instructor.
Credit—five hours
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 SMD course BST 421)
Prerequisites: GBA 411, 412, and differential calculus.
Credit—four hours
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. (Alternate years)

529. Applied Multivariate Analysis
(Same as SMD course BST 441)
Prerequisite: APS 514.
Credit—two hours
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. (Alternate years)

531. Applied Econometrics
The course aims to provide PhD students with a broad set of applied econometric skills. The contents of the course are designed 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 is 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, is 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 (MGC)
Ronald M. Schmidt
Area Coordinator

401. Communicating Business Decisions (Module I)
402. Communicating Business Decisions (Module II)
403. Communicating Business Decisions (Module III)

Strong communication skills are essential for future leaders. The goal at Simon is to establish principles and standards for written and oral communication that will apply not only to Simon coursework but throughout the students' business career. Students are encouraged to think strategically about business communication, and the emphasis on applied communication integrates effective writing and presentation skills with practical, hands-on projects. Because the job search incorporates many key communication skills, the first module of instruction focuses on cover letters, résumés, interviewing, networking, and e-mail protocol. In the second module, business problems assigned in other core courses are structured to take various forms, such as a 10-minute presentation to the board of directors or a one-page executive memo, which are then evaluated by the faculty to reinforce the importance of the “Communicate” (Ct.) element of the school's new F.A.Ct. initiative. The final module concludes with a school-wide case competition that takes place at the end of the first year.

404. F.A.Ct. Workshop
The course required of all students starting in the Accelerated MBA program is taken by students in groups of 12 to 16 working with a faculty member on an unstructured/complex managerial situation that requires framing of the problem, data/fact collection, analysis, and communication. The class meets for a weekly discussion session where the students discuss and debate their positions.
BUSINESS ENVIRONMENT AND PUBLIC POLICY (BPP)

Ronald W. Hansen
Area Coordinator

Master’s-Level Courses

426. Macroeconomics
Prerequisite: STR 401.

Macroeconomics is the study of how economies grow and fluctuate over time and how they interact with one another. This course discusses economic measurement, economic growth, and the business cycle. Also discussed are 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)

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 is transactional and includes analysis of such issues as the creation and protection of intellectual property, technology licensing, global expansion, and internet commerce. The course includes, as a context for applied learning, a term project involving the creation and evolution of a selected new venture opportunity. (Offered at the discretion of the instructor.)

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 is on United States law, there are selected references 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 is 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
(Same as ACC 433)
Prerequisite: BPP 432.

This course is a continuation of BPP 432. Topics include bankruptcy, real property, personal property, sales, secured transactions, negotiable instruments, insurance, trusts and estates, and consumer protection. The course also includes discussions of ethics and professional responsibilities.

440. Evolving Medical Markets
(Same as HSM 440)

Firms supplying products and services to the health care industry face a variety of regulatory and marketing challenges that are 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 covers 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.

442. International Economics and Finance
(Same as FIN 442)
Prerequisite: FIN 402; FIN 411 recommended.

Topics include theories of international trade; exchange-rate regimes; the determination of exchange rates in a world of flexible exchange rates; the Euromarkets; the pricing of assets in open economies; international financial management and the theory of multinational corporations; foreign exchange exposure; analysis of currency forward, future, option, and swap contracts; capital budgeting for foreign projects; and financing international trade.

COMPETITIVE AND ORGANIZATIONAL STRATEGY (STR)

James A. Brickley
Area Coordinator

Master’s-Level Courses

401. Managerial Economics
Credit—four hours

This core course applies the fundamental tools of price theory—consumer and firm behavior, demand and supply, the allocation of resources, competition and monopoly—to management decision making. Interaction of the firm with its customers, competitors, and markets is discussed.

403. The Economic Theory of Organizations
Prerequisite: STR 401.

The course combines basic economic concepts introduced in STR 401 with agency theory and the concept of specific knowledge to develop a framework for addressing and solving important organizational problems. Key elements include the assignment of decision rights, the performance-evaluation system, and the compensation/incentive system. Each of these elements is analyzed in detail. The framework is applied to analyze a variety of contemporary managerial topics such as total quality management, business-process reengineering, outsourcing, transfer pricing, and leadership and business ethics.

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. For students who plan to take both STR 421 and STR 422, the instructors of both courses recommend taking STR 422 first. Each course can be taken independently of the other, but students planning to take both courses benefit from learning the tools of game theory in STR 422 before applying them to competitive strategy decisions in STR 421. Students planning to take only STR 421, on the other hand, may want to consider taking the course in their first year because of its broad scope.

422. Strategic Decision Making: Theory and Practice
Prerequisite: STR 401.

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 to 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. For students who anticipate taking both STR 421 and STR 422, the instructors of both courses recommend taking STR 422 first. Each course can be taken independently of the other, but students planning to take both courses benefit from learning the tools of game theory in STR 422 before applying them to competitive strategy decisions in STR 421.

423. Pricing Policies
(Same as MKT 414)
Prerequisites: STR 401 and MKT 402.

This course prepares future managers to analyze the environment in which their firm operates and to arrive at an appropriate pricing policy for the product or service. There are several components: cost definition and measurement; measurement of price sensitivity and the implied market segmentation; strategic analyses vis-à-vis competitors and distributors; and the legal aspects of pricing. The course builds on STR 401, MKT 402, and APS 411 but goes further in discussing specific pricing policies used by firms. Topics include quantity discounts, bundling and tie-in sales, product line pricing, pricing via distribution channels, cooperative versus opportunistic pricing, and competitive bidding.

424. Managing Human Resources
Prerequisite: STR 401; 403 recommended.

This course analyzes human resource management within the framework of economic theory. 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 systems, managing workforce diversity, employee relations, and the coordination of human resource policies and business strategy.

425. Organization of Industry and Markets
Prerequisite: STR 401.

This course analyzes the structure of industries and markets and considers how firms act strategically to influence the evolution of the environment in which they operate. It also examines the impact of government regulations and the types of strategies that firms use to influence their regulatory environment. The material of STR 401 and 403 is extended to include the interaction among firms and the impact of government policies on the firm. (Offered at the discretion of the instructor)

426. Property Rights and the Law
Prerequisite: STR 401.

This course examines how property-right assignments affect individual behavior and the use of resources. The analysis provides useful managerial insights into how the legal system affects private contracting, economic activity, and the structure of organizations. (Offered at the discretion of the instructor)

427. Organizational Behavior

The course analyzes behavioral approaches to organizations, stressing implications for managerial practice. Topics include organization and job design, group dynamics, motivation, and leadership.
430. Health Sciences Management and Strategy
(Same as HSM 430)
Prerequisite: STR 401, 403 and 421 recommended.

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 leave the course with an ability to think productively about management and strategy challenges within each of the three health science sectors.

431. Practicum on Competitive Strategy
Prerequisite: completion of core courses.

This course provides students with hands-on experience in running a consulting project. It develops skills in formulating 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. The projects in this course have a broader orientation than the functional area projects and are geared toward the integration of different topics as well as toward more strategic thinking. Teams of four to five students are responsible for the individual projects and meet with the instructor individually every week. The organizations submitting projects must be willing to spend time with students and to provide appropriate data. (Offered at the discretion of the instructor.)

438. B2B Pricing
(Same as MKT 438)

Students 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. It examines the issue of double marginalization and how two-part tariffs resolve the problem. Also examined are 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, the course analyzes 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 the 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 Topics in Pricing
(Same as MKT 439)
Prerequisite: MKT 414/STR 423.

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. Organizational Governance and Control
Prerequisites: STR 401 and 403.

New organizations have to choose their initial organizational design and associated control mechanisms. Organizations also frequently restructure. For example, entrepreneurial firms become publicly traded, partnerships convert to corporations, closed-end funds become open-end mutual funds, nonprofits convert to for-profit status, mutual insurance companies convert to publicly traded corporations, franchise companies buy back units, and so on. Organizations also frequently change their basic control mechanisms such as their voting rules and board structure. Management succession is an important consideration in most firms. These organizational choices affect value and the associated prices of the stocks and bonds issued by organizations. For example, a 1999–2000 survey by McKinsey & Company of leading institutional investors indicates that over three-quarters of these investors consider governance practices at least as important as financial performance when evaluating companies for investment. Institutional investors (such as TIAA-CREF) have dedicated staffs to analyze and promote effective governance. Senior and financial managers, consultants, and investment bankers involved in issuing securities, making or defending (for example, in a court of law) organizational decisions, and interacting with institutional investors benefit from knowing the relevant trade-offs and related empirical literature. This course builds on STR 401 (The Economic Theory of Organizations) 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.
441. Executive Strategy Seminar
Prerequisite: completion of core courses.

In this course, students apply skills acquired in earlier courses to a variety of case-like strategic settings. It thus contributes to the transition from student to manager. An experienced member of the business community staffs the course and provides the necessary integration with the rest of the curriculum. (Offered at the discretion of the instructor.)

STR 442. Special Topics in Strategy
Prerequisite: permission of the instructor.

Special topics are generally those that 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. (Not offered every year)

PhD Courses

501. Organizational and Competitive Strategy Seminar
(Also as AEC 503)

This course is a continuation of AEC 501 and 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.

401. Information Systems for Management
Credit—four hours

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 information systems; database and knowledge management systems; data communications; electronic commerce; business process reengineering; 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.

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 resources; 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
(Also as ECM 415)
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 object-oriented systems analysis techniques, the study of cutting-edge research results on work organization and design, and an introduction to the Visual Basic programming language for 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  
(Same as ECM 416)  
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 covered include 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 technology 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.

418. Advanced Business Modeling and Analysis Using Spreadsheets  
Prerequisite: GBA 411 or equivalent.  
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 complete the course possess cutting-edge skills in spreadsheet business modeling and analysis.

440. Electronic Commerce Strategy  
(Same as ECM 440)  
Prerequisite: CIS 401.  
This course covers electronic strategies for business to business and consumer e-commerce. This includes strategies for protecting market share by going online, ameliorating online competition using network effects and customer lock-in, positioning against other online presences, dealing disintermediation and re-intermediation, developing online communities for business 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 that 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 understanding 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 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)  
This course provides MBA 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 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 MBAs entering the industry and the skills and values necessary for success as a consultant are scrutinized. The Business Systems Consulting Process: The creation of proposals, the winning of consulting engagements, and the preparation of contracts are 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) are examined. Consulting Skills: The role of the consultant and the human dimension are discussed (e.g., personal attributes of consultants, relationship building, and team building). Diagnostic tools and data gathering techniques (e.g., questionnaires and interviews) are presented. Frameworks for problem solving and communicating recommendations also are 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.
PhD Courses
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.

ELECTRONIC COMMERCE (ECM)

Abraham Seidmann
Area Coordinator

Master’s-Level Courses
415. Business Process Analysis and Design
(Same as CIS 415)
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 object-oriented systems analysis techniques, the study of cutting-edge research results on work organization and design, and an introduction to the Visual Basic programming language for 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
(Same as CIS 416)
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 include 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 technology 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.

436. Database Marketing
(Same as MKT 436)
Prerequisites: MKT 402, GBA 411 and GBA 412.

Advances in information technology have created opportunities for firms to gather more detailed information on their customers and competitors. The enormous volume of information that companies now collect poses many new challenges. The basic question we address in this course is, “What can one do with all of this data?” Our goal is to integrate statistical models and marketing models with data and decisions. In this course, students learn how database marketing provides management with specific information needed to identify the target customer and to retain her or him for a lifetime, if possible. In the absence of database marketing philosophy, managers would be left with mass marketing and segmented marketing techniques that are not effective and efficient in today’s information intensive, high-tech global markets. What is database marketing (DM)? How is it different from traditional marketing methods? Database marketing is a segmentation process that utilizes state-of-the-art statistical methods and computerized databases of customers to reach the individual consumer. This course also examines direct marketing in depth, since the roots of database marketing are in direct marketing. Direct marketing is the type of marketing that recognizes the individual as the target rather than the entire market. Direct mail, telemarketing, catalog shopping, web-based marketing, and relationship marketing are related topics that are covered in this course.

437. Marketing on the Internet
(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 opportunities 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 consumers on the Internet; the Internet as a distribution channel; and marketing research on the Internet.
Electronic Commerce Strategy
(Same as CIS 440)
Prerequisite: CIS 401.

This course covers electronic strategies for business to business and consumer e-commerce. This includes strategies for protecting market share by going online, ameliorating online competition using network effects and customer lock-in, positioning against other online presences, dealing disintermediation and reintermediation, developing online communities for business or consumer e-commerce, and managing supply chain and customer relationships.

ENTREPRENEURSHIP (ENT)

Duncan T. Moore
Area Coordinator

Master's-Level Courses

422. Generating and Screening Entrepreneurial Ideas
(Same as GBA 422)

As the foundation course in Entrepreneurship, ENT 422 covers Idea Generation, Opportunities Screening, and 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 ideal-filtering rationale to a panel for review and feedback. Behind this evaluation process, the class reviews reference material on the subject and several accomplished entrepreneurs share their personal experiences. While the nomenclature aligns most directly to high technology, for-profit start-up companies, parallels to low-tech-no-tech, entrepreneurship, non-profits, and social entrepreneurship are discussed.

423. New Venture Development and Managing for Long-Term Success
(Same as GBA 423)
Prerequisite: completion of core courses and ENT 422.

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 non-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 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
(Same as GBA 424)
Prerequisites: completion of core courses and either ENT 422, 423, or 425. Permission of the instructor MUST be secured prior to registration.

Available to a limited number of students (10–15), 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 second-year MBA students, to be known as Simon Interns, with Rochester-area firms where they work closely with senior managers for approximately 120 hours over a 10-week quarter. In their internship, students focus on the commercial viability of the firm's offerings. This is 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 are lectures on pertinent entrepreneurial subjects as well as guest speakers.

425. Technical Entrepreneurship
(Same as OPT 481)

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 is 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 will 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 MBA students and two science/technology graduate students. Other team configurations are possible with instructor approval. Each team's business plan receives a grade, and that grade applies 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.
426. Technology Transfer and Commercialization
(Same as GBA 426)
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 transforms 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, start-up 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
(Same as GBA 427)
Students in this course work in the Office of Technology Transfer on projects that are a best fit to the students’ background and the range of inventions from the University of Rochester in science, engineering, and medicine. Projects include either marketing to existing companies or work on catalyzing a start-up company. Either type of project requires 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 is helpful. The students prepare a technology commercialization and/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 is transactional and includes analysis of such issues as the creation and protection of intellectual property, technology licensing, global expansion, and Internet commerce. The course includes, as a context for applied learning, a term project involving the creation and evolution of a selected new venture opportunity. (Offered at the discretion of the instructor.)

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 is on United States law, there is 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 is 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
(Same as GBA 435)
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.

444. Entrepreneurial Finance
(Same as FIN 444)
Prerequisites: FIN 402 and 413.
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 (FIN)

Jerold B. Warner
Area Coordinator

Master’s-Level Courses

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 an 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, 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.

423. Corporate Financial Policy and Control
Prerequisites: FIN 402 and 411 and 413.
This course examines the theory and empirical evidence for models of corporate financial policy; analysis of new issues of securities, recapitalizations, stock repurchases, and the market for corporate control (tender offers, mergers, proxy fights, and corporate voting rights); and emphasizes critical evaluation of the evidence for different models of corporate financial policy.

424. Options and Futures Markets
Prerequisites: FIN 402 and 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. Financial Institutions
Prerequisites: FIN 402 and 411 and 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 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
Prerequisite: established by the instructor.
Special topics are generally those that are not well covered in other courses. The specific content varies, depending on faculty interest. (Not offered every year)

442. International Economics and Finance
(Same as BPP 442)
Prerequisite: FIN 402 and 411 recommended.
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 and 411 and 413.
This course provides an introduction to financial theories and tools an entrepreneur needs to start, build, and harvest a successful venture. Cases and lectures 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 IPOs 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 411.
The objective of this course is to undertake a rigorous study of fixed-income securities and markets. A variety of fixed-income securities are discussed, including coupon bonds, callable and putable 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 are also discussed. In addition, students study some tools that are useful in bond portfolio management, including horizon analysis, duration, optimization techniques for constructing bond portfolios, and models 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.

PhD Courses
501. Workshop in Finance
Seminars discussing current research in finance by faculty, students, and guest speakers. PhD students are expected to participate actively.

505. Theory of Finance
The goal of this course is to present the theory of asset pricing and portfolio selection in multiperiod 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 concepts: pricing kernels and martingales. The course draws connections between these concepts and makes plain the similarities between discrete and continuous time models. Applications include term structure models, portfolio choices, and the pricing of corporate securities.

511. Advanced Financial Economics
Prerequisite: FIN 505 recommended.
The course builds on the basic theory presented in FIN 505, Theory of Finance. This course emphasizes some relatively advanced mathematical methods that are used in the research literature of financial economics. The objective of the course is to provide students with enough knowledge of these methods that they can begin to use them in nontrivial ways in their research. Particular emphasis is given to topics that are costly or difficult to learn on an individual basis. (Alternates with FIN 534)

532. Advanced Topics in Capital Markets
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.

534. Advanced Topics in Corporate Finance
This course examines the determinants and consequences of corporate financial policy choices. Topics include capital structure, bankruptcy and financial distress, payout policy, corporate control, leasing, hedging and insurance, raising capital, concentrated ownership, board structure, and executive compensation. Specific topics vary from year to year. The course investigates both the theoretical and empirical literature on these topics.
GENERAL BUSINESS ADMINISTRATION (GBA)

Rajiv M. Dewan
Area Coordinator

Master’s-Level Courses

411 and 412. Framing and Analyzing Business Problems 1 and 2

Framing and Analyzing Business Problems is a two-quarter sequence. Both courses focus on teaching students how to approach unstructured business problems logically and empirically with the goal of informing business strategy and operational decisions. Issues stressed throughout the two courses include (1) framing the relevant business question; (2) hypothesis formulation; (3) searching for relevant information and data; (4) describing data and graphical analysis; and (5) communicating the analysis. While the courses are not meant to be “run of the mill” statistics courses, they introduce important statistical concepts and tools, including basic statistical concepts (random variables, probability, basic descriptive statistics, expectations, and variances); probability density and distribution functions (continuous and discrete distributions, joint and marginal distributions, binomial distribution, and normal distribution); decision, risk and sensitivity analysis (risk and risk attitudes, decision trees, value of information, and Bayes’ rule); estimation (sampling, parameter, estimates, and confidence intervals); hypothesis testing (tests of means and proportions and of differences) and regression analysis.

422. Generating and Screening Entrepreneurial Ideas
(Same as ENT 422)

As the foundation course in Entrepreneurship, ENT 422 covers Idea Generation, Opportunities Screening, and 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 reviews reference material on the subject, and several accomplished entrepreneurs share their personal experiences. While the nomenclature is aligned most directly to high technology, for-profit start-up companies, parallels to low-tech-no-tech, intrapreneurship, nonprofits, and social entrepreneurship are discussed.

423. New Venture Development and Managing for Long-Term Success
(Same as ENT 423)

Prerequisite: completion of core courses and ENT 422.

The focus of GBA 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 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
(Same as GBA 424)

Prerequisites: completion of core courses and either ENT 422, 423, or 425. Permission of the instructor MUST be secured prior to registration.

Available to a limited number of students (10–15), 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 second-year MBA students, to be known as Simon Interns, with Rochester-area firms where they work closely with senior managers for approximately 120 hours over a 10-week quarter. In their internship, students focus on the commercial viability of the firm’s offerings. This is 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 are lectures on pertinent entrepreneurial subjects as well as guest speakers.

426. Technology Transfer and Commercialization
(Same as ENT 426)

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 transforms industries. The identification and evaluation of technologies with high potential is today a key to success. With the decline of corporate research functions, new 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, start-up 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
(Same as ENT 427)

Students in this course work in the Office of Technology Transfer on projects that are a best fit to the students’ background and the range of inventions from the University of Rochester in science, engineering, and medicine. Projects include either marketing to existing companies or work on catalyzing a start-up company. Either type of project requires 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 is helpful. The students prepare a technology commercialization and/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.

435. Negotiation Theory and Practice: Bargaining for Value
(Same as ENT 435)

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. 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 professional conflicts of interest in financial services, information disclosure in advertising, and fairness in sales practices and in hiring and treating employees. Finally, it analyzes some ethical questions specific to business decisions in the health sector.

444. FACt Business Project

This course is based on a project, either generated by a faculty member or provided by a corporate partner that provides students with an opportunity to apply the Simon FACt framework and the management theory taught in the core and elective courses. Either way, the faculty member guides and mentors the teams in the use of the management theory to solve a real-world business problem. The teams are required to present their ideas to the class and project sponsor. The grade is based on all aspects of FACt: framing of the problem, analysis using the management theories, and the communication/presentation of the project.

450. Accounting, Economics, and Finance for MS Students
(Same as HSM 450)

Prerequisite: available only to MS students concentrating in Marketing and Health Sciences Management.

This course is designed to present the fundamentals of economic, financial, and accounting analysis. It covers concepts needed to serve as a foundation for concepts developed throughout subsequent courses in the MS 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 addresses the principles of capital budgeting. The first five weeks of the course are an economics and statistics module. Basic concepts of managerial economics are covered, including demand and demand elasticity, marginal revenue, key cost concepts (fixed costs, variable costs, marginal costs, and sunk costs), and profit maximization. The module also introduces basic statistical concepts such as probability distribution functions, estimation (sampling, estimates, and confidence intervals), and hypothesis testing. The remaining six weeks of the course—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, financial statement analysis, development of pro forma financial statements, cash vs. accrual accounting, depreciation methodology, introduction of management accounting concepts, and capital budgeting. Capital budgeting includes net present value (NPV), payback, accounting rate of return (ARR), and internal rate of return (IRR).

461. Core Economics for MS Students

Prerequisite: available only to MS students concentrating in Finance, Marketing, or Health Care Management.

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, and sunk costs), profit maximization, understanding the competitive environment and strategic decision making, and net present value calculations.
462. Core Statistics for MS Students  
**Prerequisite:** available only to MS students concentrating in Finance, Marketing, or Health Care Management.

This course is taught to equip students with the statistical skills necessary for success in marketing positions. 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 nonparametric tests.

482. Business Policy  
**Prerequisite:** completion of core courses.

This capstone course focuses on how corporations and other forms of enterprise establish aims and goals, determine strategies to achieve those aims and goals, and subsequently, how those strategies are executed. Emphasis is given to the concerns of top management leaders in anticipating and reacting to changes in the economic environment, changes in the nature of market competition, and how action is stimulated to produce desired responses in the enterprises they govern. The course consists of lectures and discussions supplemented by the analysis of recent complex cases involving well-known international corporations in contemporary situations. Both individual and team reports are required, and students are expected to use computer-based market forecasting and financial-simulation techniques to analyze the “what if” problems faced by senior managers in these cases. Oral and written reports are graded on the clarity of presentation as well as the quality of analysis. (Offered at the discretion of the instructor.)

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 CEO’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 United States 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. (Offered at the discretion of the instructor.)

490. American Business Practice  
**Prerequisite:** completion of all core courses.  
**Credit—**one hour

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, including 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. GBA 490E, Integrating Business Theory and Practice, which cannot be used to complete a concentration in the MBA program, is open to international students who are not yet eligible to work in the United States or to any domestic student who has completed at least two quarters of study. Students complete a GBA 490E form, meet with the Student Services director, and then bring the approved paperwork to the Simon School registrar’s office for processing. Upon completion of the internship assignment, the student must prepare a one- to two-page report detailing the outcome(s) and stating whether the proposed learning objectives were met.
491. Reading Course
Supervised reading and study on topics beyond those covered in existing formal courses. (Offered at the discretion of individual faculty.)

492 and 493. International Exchange Programs
Credit—GBA 492, six hours; GBA 493, nine hours
The International Management Exchange option of the International Management concentration gives students opportunities to participate in one of several exchange programs. (Open to full-time and part-time MBA students.)

494. Foreign Language Transfer Credit
Credit—three hours

PhD Courses
591. PhD Reading Course
594. PhD Independent Study
595. PhD Research
995. Continuation of Doctoral Enrollment
999. Writing Dissertation

HEALTH SCIENCES MANAGEMENT (HSM)
Gerard J. Wedig
Area Coordinator

Master’s-Level Courses
420. Business Economics of the Health Care Industry
This course aims to educate students about the unique business institutions and problems of the health care industry so that students can be prepared to apply their core business knowledge to solve managerial problems in the health care industry. The course consists of an overview of the major institutions of the U.S. health economy as well as an economic analysis of these institutions.

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 class allows the student to understand how costs are reported and how to use this information to make decisions within the health services entity. The following topics are examined within a health services setting: cost allocation, cost-volume-pricing analysis, budgeting and variance analysis, and activity-based costing.

430. Health Sciences Management and Strategy
(Same as STR 430)
Prerequisite: STR 401; 403 and 421 recommended.
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. Students leave the course with an ability to think productively about management and strategy challenges within each of the three health science sectors.

431. Applications of Corporate Finance and Governance to Health Care
Prerequisites: STR 403 and 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)
Prerequisite: OMG 402 or an equivalent.
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 study the operations of various types of health care provider organizations (such as hospitals, HMOs, group practices, nursing homes, etc.) and other participants in the industry (such as insurance companies, pharmaceutical companies, suppliers, and consulting companies). Topics that are studied include patient and provider scheduling, capacity management, providing services and supplies to health care providers, new product development, and integrated delivery systems.

440. Evolving Medical Markets
(Same as BPP 440)
Firms supplying products and services to the health care industry face a variety of regulatory and marketing challenges that are 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 covers 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.

**Specialized Courses**
The courses below are only available to students in the Master of Science in Business Administration with a concentration in Medical Management program.

**450. Accounting, Economics, and Finance for MS Students**  
(Same as GBA 450)  
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 serves as a foundation for concepts developed throughout subsequent courses in the MS 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 addresses the principles of capital budgeting. The first five weeks of the course focus on an economics and statistics module. Basic concepts of managerial economics are covered including demand and demand elasticity, marginal revenue, key cost concepts (fixed costs, variable costs, marginal costs, sunk costs), and profit maximization. The module also introduces basic statistical concepts such as probability distribution functions, estimation (sampling, estimates, and confidence intervals), and hypothesis testing. The remaining six weeks of the course—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, financial statement analysis, development of pro forma financial statements, cash vs. accrual accounting, depreciation methodologies, introduction of management accounting concepts, and capital budgeting. Capital budgeting includes net present value (NPV), payback, accounting rate of return (ARR), and internal rate of return (IRR).

**451. Health Care Marketing and Business Plan Development**

Basic marketing concepts are integrated with the unique institutional features of health care markets to develop a framework for producing a marketing and business plan for a health care organization. A special focus is placed on the practical elements of learning how to produce business plans.

**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 are 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. Students study the application of operations management concepts to the management of health care provider organizations (such as hospitals, group practices, HMOs, 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, 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. Designing and Optimizing Health Care Organizations**

Concepts developed in STR 403 are applied within a health care setting to teach students (1) how to design compensation plans that attract, retain, and motivate medical professionals; and (2) how to organize tasks within (and outside) the organization to achieve coordination and efficiency.

**455. Practicum in Medical Management**

This course provides students with hands-on experience with a medical management project. It develops skills in formulating 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. Practicum in Medical Management 2**  
Prerequisite: HSM 455.

A continuation of the project from HSM 455.
MANAGEMENT SCIENCE METHODS (MSM)

Tolga Tezcan
Area Coordinator

Master’s-Level Courses

400. Mathematics Review
Credit—none
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. The objective of this course is to bring incoming MBA or MS students “up to speed” with respect to the mathematical and statistical knowledge expected of them. The complexity of the course is on part with (college) freshman-year calculus, algebra, and introduction to probability and statistics. Necessary theories and intuition behind them are covered. The focus of the course is primarily on applications in business, economics, and related areas. While this course is not a required course for the credits required for the MBA or MS degree, it is a graded class to give students an assessment of their mathematical skills. The GPA appears on the official transcript but is not included in the cumulative GPA for the MBA or MS program. (Summer)

PhD Courses

501. Quantitative Methods Colloquium
Credit—none
This is a forum for the presentation of on-going and recently completed work by students, faculty, and guest lecturers.

502. Linear Algebra and Linear Programming
This course provides an introduction to linear algebra and linear programming. The topics covered are definitions and examples, introduction to linear algebra, the simplex method, starting solution and convergence, the revised simplex method, duality and sensitivity analysis, and (if time permits) the structure of convex polyhedral sets. Primarily for entering doctoral students. (Summer)

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 includes advanced topics in stochastic processes, with emphasis on problem modeling and computation. The following topics are covered: models using discrete time Markov chains, optimal stopping and discrete time Markov chains, models using continuous time Markov chains, Markov decision processes for discrete time Markov chains, and, if time permits, diffusion processes/martingales.

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 draws upon both deterministic optimization methods and stochastic models but not their theory. Focus is on linear programming (including integer and network formulations), basic queuing 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.

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. Queuing Theory and Applications
Prerequisite: MSM 504 or SMD course BST 402 or permission of the instructor.

The course offers an 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 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 (MKT)

Dan Horsky
Area Coordinator

Master’s-Level Courses

402. Marketing Management
Prerequisites: STR 401 and GBA 411 and 412 (may be taken concurrently).

This course is an 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, GBA 411 and 412.

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 learn the fundamentals of economic-value analysis and break-even analysis, and are made familiar with strategies such as bundling, tie-in sales, quantity discounts, product-line pricing, and demand buildup. The course covers 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. Product Planning
Prerequisites: MKT 402, GBA 411, and 412.

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. It examines 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, the course explores 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. The class continues 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 and Sales Promotion  
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. Distribution Channels and Sales Force Management  
Prerequisite: MKT 402.

This course deals with the issues that arise in designing and managing distribution channels and sales forces. 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 sales force 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 sales force front, the course delves into a number of critical issues such as performance measurement, territory decision, quotas, and compensation design.

436. Database Marketing  
(Same as ECM 436)  
Prerequisites: MKT 402, GBA 411 and 412.

Advances in information technology have created opportunities for firms to gather more detailed information on their customers and competitors. The enormous volume of information that companies now collect poses many new challenges. The basic question addressed in this course is “What can one do with all of this data?” The goal is to integrate statistical models and marketing models with data and decisions. In this course, students learn how database marketing provides the management with specific information needed to identify target customers and to retain them for a lifetime, if possible. In the absence of database marketing, managers would be left with mass marketing and segmented marketing techniques that are not effective and efficient in today’s information-intensive, high-tech, global markets. What is database marketing (DM)? How is it different from traditional marketing methods? Database marketing is a segmentation process that utilizes state-of-the-art statistical methods and computerized databases of customers to reach the individual consumer. This course also examines direct marketing in depth, since the roots of database marketing are in direct marketing. Direct marketing is the type of marketing that recognizes the individual as the target rather than the entire market. Direct mail, telemarketing, catalog shopping, web-based marketing, and relationship marketing are related topics that are covered in this course.

437. Marketing on the Internet  
(Same as ECM 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 with 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)  
Prerequisite: MKT 414 and STR 423.

Students 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 and then examines the issue of double marginalization and learns how two-part tariffs resolve this problem. The course also examines 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, 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 the manufacturer’s advertising on the retailer and on the channel overall is analyzed. 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 planning on working on the retailer side or on the manufacturer side of this industry.

439. Advanced Topics in Pricing  
(Same as STR 439)  
Prerequisite: MKT 414 and STR 423.

This course builds on MKT 414 and 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.

441. Brand Management Workshop
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 its findings. Typically, this amounts to performing a brand review.

442. Special Topics in Marketing
Prerequisite: permission of the instructor.

Special topics are generally those that are not well covered in 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. (Not offered every year)

448. Brand Strategy Workshop
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: (1) 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. (2) 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 develops 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 are 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 are developed from basic economic principles. Core MBA subject matter is 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 course consists of lectures and classroom discussion of contemporary cases in services and tangible products. The case discussions illustrate how the entire organization is affected by strategic marketing decisions. The definition of new core capabilities and the use of existing unique resources in creating competitive advantage are explored. Special emphasis is given to the impact of globalization and technology on the formulation and implementation of marketing strategy.

451. Computation and Analysis of Advanced Quantitative Marketing Models

The course is primarily designed for students (both MBA and PhD) who have a quantitative inclination towards marketing and strategy but also is useful for students in other areas looking to hone their quantitative skills. The course guides students through various aspects of data-related issues, problem framing, programming and computational analysis, and the communication and presentation of managerially relevant findings. The course relies heavily on using SAS® as a computational engine and MS® EXCEL® as a presentation and simulation device. All instruction is “hands-on” and students should expect to be proficient in SAS® by the end of the quarter. The course has some assignments and a “real-world” consulting project. Students are exposed to the theoretical underpinnings and practical applications of various analytical and econometric models. These include, but are not limited to, Linear and Nonlinear Regression (Demand/Share Estimation), Systems of Equations Estimation (Market Equilibrium Models), Models for Binary and Ordered Responses (Scale Responses), Multinomial Discrete Choice Models (Consumer and Brand Choice), Other Limited-Dependent Variable Models including Count, Censored, and Duration models (Interpurchase time, Selectivity, etc.), Multivariate Methods (Factor Analysis, Cluster Analysis, etc.). This course is not for everyone and requires some proficiency in (or aptitude for) math/statistics and programming.
**PhD Courses**

**501. Workshop in Marketing**  
**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.

**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 512.

**Operations Management (OMG)**

Abraham Seidmann  
*Area Coordinator*

**Master’s-Level Courses**

**402. Operations Management**  
**Prerequisites:** CIS 401, GBA 411, and 412.  
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 Management**  
**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 is 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, are studied and applied both in class and assignments. Supporting software, such as Enterprise Resource Planning (ERP) and supply chain tools, also are discussed. After completing this course, students should be able to characterize the supply chain issues in an industry/firm, and evaluate current practice as well as identify improvement opportunities.

**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. The methodologies developed in this course provide a framework for analysis that remains constant amid the many different types of services analyzed. Please note that this course is case intensive.

**413. International Manufacturing and Service Strategy**  
**Prerequisite:** OMG 402.  
Operations strategy describes how a firm’s long-term operations decisions affect its ability to compete. Areas of critical importance to firms often include location and distribution policy; management and global networks; outsourcing and vertical integration decisions; coordination of operations with other functions such as finance; accounting and finance; technology acquisition; and new product development. Special emphasis is placed on the impact of international issues on operations strategy. A variety of cases are used to demonstrate applications.

**415. Process Improvement**  
**Prerequisite:** OMG 402.  
This course teaches a systematic method for understanding and improving ongoing business processes. The techniques you learn 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 learned 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 is strong emphasis on the process of data acquisition. A small outside project for the class and a series of in-class simulations support the process of acquiring the right data and learning the analysis tools. Two additional tools that support the questioning that leads to good data acquisition are process mapping (of the process that’s being improved) and thought process mapping (of the process that was used 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)  
Prerequisite: OMG 402 or an equivalent.

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. This course examines the operations of various types of health care provider organizations (such as hospitals, HMOs, group practices, nursing homes, etc.) and other participants in the industry (such as insurance companies, pharmaceutical companies, suppliers, and consulting companies). Topics studied include patient and provider scheduling, capacity management, providing services and supplies to health care providers, new product development, and integrated delivery systems.

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)

This course provides MBA 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 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 MBAs entering the industry and the skills and values necessary for success as a consultant are scrutinized. The Business Systems Consulting Process: The creation of proposals, the winning of consulting engagements, and the preparation of contracts are 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) are examined. Consulting Skills: The role of the consultant and the human dimension are discussed (e.g., personal attributes of consultants, relationship building, and team building). Diagnostic tools and data gathering techniques (e.g., questionnaires and interviews) are presented. Frameworks for problem solving and communicating recommendations also are 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.

PhD Courses

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, and performance evaluation of dynamic systems, business expert systems, and artificial intelligence.

531. Analysis of Production Systems

This 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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Dena Swanson, PhD (Emory)
Associate Professor of Education

Andrew Wall, PhD (Illinois)
Associate Professor of Education

Assistant Professor

Mariam Abugasea Heidt, PhD (Wyoming)
Assistant Professor of Education (clinical)

Chelsea BaileyShea, PhD (Rochester)
Assistant Professor of Education (clinical)

Edward Brockenbrough, PhD (Pennsylvania)
Assistant Professor of Education
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 education 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 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 experiences. First, after having taken at least 18 credits in the program, all doctoral students must submit a portfolio for review. The portfolio review is evaluative, but the feedback offered by faculty is also 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 are then expected to 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 throughout the program. Full-time students must register for at least 12 credit hours, or nine credit hours with an assistantship, during every fall and spring semester (excluding summer session) until the degree program is completed. Continuous registration for part-time students means registration for a total of nine credit hours every academic year sequence of summer-fall-spring 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 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 in Educational Contexts; 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.

**EdD in Education**
The EdD degree is available with the following areas of concentration: K–12 School 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 research.

Students completing the EdD in Mental Health Counseling and Supervision are automatically licensure-eligible for the New York State License in Mental Health Counseling (graduates must then complete a state licensing exam and 3,000 hours of post-degree supervised work to become licensed mental health counselors).

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.

**Certificate of Advanced Study**
Under certain circumstances, the Warner School awards a Certificate of Advanced Study. The certificate is not a degree, nor does it constitute a legally recognized credential. It does, however, formally attest to the successful completion of 60 credits of graduate study.

**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 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 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
Multiple Disabilities. 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 specializing in urban education can apply to the Urban Teaching and Leadership Program, which includes additional experiences and coursework focusing on teaching in urban settings.

Programs for Current Teachers

The Warner School also 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.

- **MS in Education** (leading to NYS certification at a new grade level or in a different specialization) 30 credits
- **MAT in (Subject Area of Specialization)** 30 credits
- **MS in Inclusive Education** (also satisfying all requirements for NYS certification in Teaching Students with Disabilities in the same area of specialization) 30–35 credits
- **MS 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—a licensure exam and 3,000 hours of post-graduate 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.

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* 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.

† For those who are interested in working with select special populations, we recommend that you tailor electives and internships to further those interests. Students can choose electives and internships in the following license-eligible areas of focus: Gerontological Counseling and College Counseling.
MS in Educational Administration, leading to SBL certification: 36 credits

MS in Educational Administration, leading to SDL certification: 60 credits

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.

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

MS in Education (with specializations in Early Childhood, Elementary, Inclusion/Special Education, Literacy, Mathematics, Science, or Social Studies) 30 credits

MS in TESOL (for 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, General Higher Education Administration, or Higher Education Student Affairs Administration) 36 credits

MS in Educational Policy 30 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 Building and School District Leadership (27 credits—assuming that additional 36 graduate credits have been previously completed)
School Building Leadership (24 credits—with specialization in Catholic and other private schools (24 credits)

Non-Degree Programs Leading to NYS Professional (Permanent) Certification in School Counseling

(12 additional credits)

Non-Degree Programs Leading to Warner Certificates
The Warner School also offers the following non-degree programs consisting of a series of courses and possibly internships that lead to internal Warner certificates:

Urban Teaching and Leadership (12 credits), a three-year sequence including two courses and six one-credit seminars for certified teachers interested in urban settings.


Interdisciplinary Programs

MS in Health Professions Education, 30-credit program offered through the Warner School in collaboration with the School of Nursing and the School of Medicine and Dentistry.

MS in Human Development (with a specialization in Applied Behavior Analysis) 42 credits

Non-Degree Program and Specialization in Applied Behavior Analysis, a six-course plus internship sequence. The Applied Behavior Analysis (ABA) specialization provides students with all the coursework required to take the Board Certified Behavior Analyst (BCBA) Examination. The program is offered in collaboration with the Division of Neurodevelopmental and Behavioral Pediatrics at the University of Rochester Medical Center.

Program Evaluation Certificate, a non-degree post-master’s series of courses and internships to prepare program evaluators (may also be earned as part of the accelerated EdD programs in Educational Leadership).

Certificate in Online Teaching, a 13- to 15-credit program that can be completed as a standalone, non-degree program or as an addition/enhancement to other University of Rochester programs.

* 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.
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. 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.

Educational Policy
A Master of Science (MS) degree in educational 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 schools, school systems, and the lives of children to influence policy design, implementation, and evaluation and serve as a catalyst for improving America’s schools. The 30-credit program makes it possible for candidates to receive their degree in one year of full-time study (if starting in the summer or taking a few courses as an undergraduate). 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, and districts, where they will help formulate new strategies and evaluate their effect. 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 in 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 forces that shape growth over the life course. 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, research, or Applied Behavior Analysis (ABA). The ABA specialization provides students with all the coursework required to take the Board Certified Behavior Analyst (BCBA) Examination and was the second program nationwide approved to do so; the program is offered in collaboration with the Division of Neurodevelopmental and Behavioral Pediatrics at the University of Rochester Medical Center.

Health Professions Education
A new Master of Science (MS) degree in health professions education, an interdisciplinary program designed by and offered through a collaboration of the Warner School, the School of Nursing, and the School of Medicine and Dentistry at the University of Rochester, is offered for health care professionals, including nurses, doctors, physical therapists, and nutritionists who are in health care education and those who are interested in moving 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.
SCHOOL-WIDE COURSES

All the courses below carry three graduate credit hours, unless otherwise noted.

For a complete listing of courses, visit the Warner website at www.warner.rochester.edu.

ED 400. Topics in Teaching and Schooling, Part 1
Prepares teachers to address the varied needs of their students and school, beyond typical curricular and academic responsibilities. Topics addressed include conflict resolution, educational law, ethics, listening and counseling skills, career preparation, and school and community relations. Also includes workshops on child abuse and violence prevention required by New York State. This is a two-semester course. Non-matriculated students discouraged from taking this course; select few by permission of instructor. (Fall and Spring)

ED 403. Disability and Early Childhood
Develops an understanding of disability, especially as it impacts young children. Addresses the inclusion debate, as well as the diagnosis, classification, and assessment of young children with disabilities. Examines the historical context for early intervention and special education and the institutional approach to disabilities, and utilizes that context to critically examine and discuss current intervention and educational practices for young children with diverse developmental paths and learning abilities. Introduces some strategies for working with young children with disabilities in various contexts and for developing collaborative partnerships and teams to best meet the full range of needs of young children with disabilities. (Summer A, even years)

EDE 405. Professional Development Practicum 1

ED 410. History of American Education
Explores education broadly as the formal or conscious transmission of culture in family life, colleges, peer groups, youth agencies, religious and cultural organizations, and the media. Investigates the processes of cultural transmission across four centuries of American history, beginning in the mid-1600s, but with the major emphasis on post-1900 themes. Intended as a first foundation course in the history of American education. (Summer and Fall, occasionally)

ED 411. Philosophy of Education
Examines a range of contemporary controversies and historically influential philosophical theories of education as a vehicle for critical reflection on the political, moral, epistemic, and linguistic aspects of educational practice. Topics include the place of education in a just and stable society; the role of education in promoting human freedom, goodness, and well-being; the nature of knowledge and human excellence, and how they develop; the curriculum and how to teach for understanding and intellectual autonomy; the relative authority and responsibility of family and state in providing and determining the content of education; and the issues arising from differences of culture, religion, and ability. (Summers, even years)

ED 412. Sociology of Education
This course examines the relationship between education and society by reviewing major theoretical perspectives and issues relating to the sociology of education. Topics 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. (Spring)

EDU 414. American Educational and Linguistic Practices
Prerequisite: International students for whom English is not their first language.

Designed to lend support to incoming students who are making the transition to studying in an American university, this course explores U.S. academic culture, language, and customs. Communication skills and practices in classroom discourse are addressed, giving students the understanding and skills needed to interact effectively with professors and other students within a university classroom. Also discusses university expectations for academic reading and writing, including the appropriate use of sources (avoiding plagiarism) and provides instruction in effective strategies and skills to meet those expectations. (Fall)

ED 416. Managing Crisis: Catastrophe, Violence, and Trauma in School and University Settings
This interdisciplinary course is designed to prepare educational professionals to effectively address issues of school violence and examine current intervention theory, research, and applications. Students study domestic violence, including child, spousal, and elder abuse; work-related violence; suicide; and the association between substance abuse and violence. Provides a foundation in violence prevention and control across disciplines (including public health, nursing, law, medicine, social work, law enforcement, education, psychology, etc.). School teachers, counselors, and administrators interested in violence prevention and control study models for explaining, predicting, and preventing violence; acquire the skills to effectively evaluate violence prevention strategies and programs; and learn what baseline data to compile for predicting violence in their schools and classrooms. (Fall, occasionally)

EDU 416. Conflict Management in Schools and Universities
Provides emerging educational leaders with effective conflict management skills to optimize the daily performance of faculty, staff, and students to solve problems, make the best decisions, and achieve educational goals. Examines the theoretical underpinnings of conflict resolution, the practice of skills, and the identification of dispositions necessary for successful collaboration, negotiation, and mediation in schools and universities. (Spring)
ED 421. Reform in Public Schools
Examines how federal, state, and local reform efforts impact teaching and learning, focusing on implications for administrators, teachers, and students in American public schools. Evaluates past and current large-scale strategies to transform the organizational, curricular, and instructional capacity of schools. Considers whether such changes have improved student access, engagement, and outcomes. The influence of race, class, and gender is addressed. Topics covered include Title I, comprehensive school reform, standards-based education, and high-stakes testing. (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. (Fall)

ED 428. Ethics and Education
Explores the moral dimensions of education and educational leadership in K–12 and higher education settings. Examines a range of ethical problems associated with educational institutions and the moral dimensions of educational leadership. Explores and discusses the many philosophical questions about the nature of morality and professional ethics. Using case scenarios and model analyses, topics include the ethics of grading, academic honesty, academic freedom and censorship, educational research and experimentation, classroom management and discipline, and sexual harassment. (Summer, odd years)

ED 429. Theories of Human Development
Provides a comprehensive introduction to multidisciplinary approaches to human development within the behavioral and social sciences. Explores theories of human development and the process of individual change over time that occurs in social, cultural, and historical contexts. Examines central theories of transformation and development that explain human behavior, the environmental factors that affect both normal and abnormal behavior, and the systems (e.g., school, family, and community) that interact to affect an individual’s development. (Fall and Summer A)

EDE 429. Informal Learning—Informal Education
Explores learning that takes place outside (and near the boundaries) of formal educational settings before, during, and after the school years. Children acquire basic knowledge (e.g., language and math concepts) informally, and adults continue to learn through everyday workplace activities, social interactions, and information gathering for making decisions. During the school years, learning occurs at home and during extracurricular activities, such as sports, clubs, and museum visits. Workplace preparation often involves a blend of formal and informal learning, as evident in apprenticeships in traditional trades as well as professions such as nursing and teaching. This course examines the processes and outcomes of informal learning across the lifespan, addresses specific questions about the assumptions that guide funding for programs that support informal learning, and considers broad questions about goals for human development and learning in the twenty-first century. (Occasionally)

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. (Spring)

EDE 434. Master’s Academic Writing

EDE 435. Service-Learning, Higher Education, and the Public Good
Reviews the evolution and impact of service-learning in higher education. Specifically, explores the relationship between higher education institutions and the community and demonstrates how working toward the public good is conceptualized from a variety of perspectives. Course readings, assignments, and in-class activities help students to critically examine service-learning, higher education, and the public good. Students also engage in an ongoing project with a community partner. (Occasionally)

ED 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. (Fall)

ED 437. Diversity and Equity in Higher Education
Examines the educational history of nondominant populations. Critical race theory is used to explore the institution of higher education. While race and gender are broad topics, these issues are complicated with those of class, disability, power, and our role in the power structure. Critical multiculturalism provides the basis for transformation in higher education. (Spring)
ED 438. Sociology of School Organizations
Examines how U.S. schools organize and stratify students and the implications this has for access to high-quality schooling and postsecondary opportunities and jobs. A key focus centers on how schools have commonly dealt with both socio-demographic (e.g., race, social class, and language) and academic differences among students. (Fall)

EDU 440. Urban Teaching and Leadership Seminar 1A
Prerequisite: EDU 442 (or concurrently).
Students in the Urban Teaching and Leadership (UTL) Program participate in a series of monthly seminars offered each semester of their three-year program. Seminars address teaching and learning in urban schools and communities and provide a forum for discussing their practice and consultation with lead teachers in the Rochester City School District. Open to students accepted into the UTL Program only or by permission of instructor. (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. (Fall, occasionally)

ED 441. Urban Teaching and Leadership Seminar 1B
Prerequisite: ED 440.
Students in the Urban Teaching and Leadership (UTL) Program participate in a series of monthly seminars offered each semester of their three-year program. Seminars address teaching and learning in urban schools and communities and provide a forum for discussing their practice and consultation with lead teachers in the Rochester City School District. Open to students accepted into the UTL Program only or by permission of instructor. (Spring)

EDF 444. Field Experiences in American Higher Education
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. 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. Restricted to matriculated international students. (Fall and Spring)

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. (Summer A)

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 be assigned such a project by the instructor. (Fall)

EDF 448. Field Experience in an Academic Program
Curricular Practical Training (CPT) is a valuable part of the students’ curriculum that provides a paid or unpaid experience in their field of study. International students may apply for CPT after they have completed two semesters. The CPT provides international students an opportunity to meet and discuss various topics and ideas originating in the students’ coursework. Open to matriculated international students only. (Fall, Spring, Summer)

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, lifelong, and interdisciplinary 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. (Fall)
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. (Spring, odd years)

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, and 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 are made available during and outside of course meetings. (Summer A)

ED 470. Leading Effective Program Design
Develops skills and strategies that educational leaders need to become effective program designers. Examines research on instructional theory and practice as connected to improving student achievement. Prepares leaders to address current reform issues through consistent, systemic K–12 program design. Explores the use and application of curricular and instructional analysis. Participants design educational programs to meet the needs of specific student populations. (Occasionally)

ED 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. (Fall, even years)

ED 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. Open to non-counseling students only. (Fall)

ED 484. Online Teaching and Learning
Provides master’s 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. The course explores four major themes: the evolution of online teaching and learning since the early 1970s; the contemporary research surrounding online student learning; online instructional tools and their potential uses; and online instructional practices and pedagogy. Students in this course 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 benefit from the wisdom of practice shared by a number of guest speakers who have engaged in various forms of online teaching; and they also learn from developing an applied project around online teaching that links theory with practice. By the end of the course, students have a foundation for designing and delivering online courses in a way that supports student engagement, student reflection, and active instructor involvement. (Fall)

EDE 486. Designing Online Courses
Prerequisite: EDE 484.
This course focuses on developing the knowledge and skills needed to design, create, and teach entire courses online. Building on the foundations and skills developed in EDE 484, the course starts by examining the faculty perspective on online learning. The course reviews institutional views and motivations for engaging in online education as well as the programs and support that are necessary to be successful. Students explore national trends and research on online teaching, building a foundation of evidence for effective online learning. A conceptual framework for online teaching and learning is developed based on learning theory, and different models of instructional design are considered. Students acquire practical experience with instructional resources and Web 2.0 tools and their affordances and constraints in the online learning environment. In addition to working through the opportunities and challenges of creating an entire online course, students consider effective online teaching strategies to create an engaged online learning community. Special topics related to online teaching such as intellectual property, copyright, and plagiarism are also discussed. The course is going to be offered fully online, so students in the course can personally experience this modality as learners.

EDF 488. Practicum in Online Teaching
Prerequisites: EDE 484 and 486.
(Fall, Spring, and Summer)

EDU 497. Teaching and Learning in Higher Education
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. (Fall)

ED 513. Academic Writing for Educators
Provides a workshop setting for students to improve academic writing and develop concrete strategies for understanding and
writing literature reviews, particularly in support of doctoral writing 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. Open to doctoral students only. (Spring and Summer B)

ED 515. Writing for Scholarly Publication in the Social Sciences
Introduces the practices of professional scholarly journal publication, focusing on text development and the submission process, from selecting a target journal, preparing a manuscript for submission, responding to reviewers' comments, and negotiating timelines. Discusses strategies for turning papers, comprehensive exams, or dissertation chapters into article manuscripts. Provides an insider's view of the manuscript review process. Students either work on their own text or practice reviewing a journal article submission. Open to doctoral students only. (Occasionally)

ED 516. Designing and Evaluating Professional Development
Prerequisite: EDU 497 or permission of instructor.
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. (Spring or Summer B)

ED 516. Communicating Science for Multiple Audiences and Purposes
This course explores how the same scientific content can be drawn on to produce a wide range of types of texts (genres) for different purposes and audiences, including fellow scientists, students, general public, and potential business partners/investors. Students learn to analyze the structure of these texts and how it relates to textual purpose and specific audiences (e.g., persuasion, illustration, demonstration). Students will undertake a micro-analysis of texts to understand how language constitutes these texts to achieve the goals of the writer in relation to particular purposes and audiences. Finally, students work in teams to create various textual genres for multiple audiences/purposes from the same base scientific/technical content. This is a two-week course. (May or January)

ED 534. English-Medium Publishing in a Multilingual World
This course for international students/scholars explores the social practices related to publishing in scholarly journals and the choices that scholars make in terms of identifying and understanding the communities they wish to reach. These choices in turn affect choice of language and publishing venue and accessing the resources and networks that will support these publishing efforts. The course draws on Professor Curry's research findings about multilingual scholars writing and publishing experiences in order to present ethnographically based "heuristics." Heuristics are sets of questions related to empirical data from the research that comprise a book in development called English-medium publishing in a multilingual world: Practices, choices, and strategies. (Occasionally)

EDE 568. Advanced Seminar
Topic changes each year. Open to doctoral students only or by permission of instructor. (Spring, occasionally)

EDE 577. Advanced Seminar in Higher Education: Research Design
Prerequisites: ED 504, 507, completed or near complete comprehensive exams.
This course is primarily designed to prepare doctoral students for the process of writing their dissertation proposals. The target audience for this course is doctoral students in higher education who have completed their methods courses and their comprehensive exams and who are at or near the proposal stage of their doctoral programs. This course is not open to master's students or doctoral students in the accelerated dissertation cohorts. Enrollment in the course must be approved by the instructor. (Occasionally)

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. (Fall)

EDU 581. Clinical Teaching in Health Care Professions Education: Teaching and Instructional Methods
Prerequisites: EDU 497 required, 580 recommended.
Provides 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. (Spring)
RESEARCH METHODS COURSES

**EDE 404. Basics in Applied Quantitative Analysis**  
*Prerequisite: ED 406 or permission of instructor.*  
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. Master’s students only. (Fall)

**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. Master’s students only or by permission of instructor. (Fall, Spring, Summer A and B)

**ED 504. Quantitative Research Methods**  
*Prerequisites: ED 506, 528.*  
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. Doctoral students only or by permission of instructor. (Spring and Summer B)

**ED 505. Advanced Quantitative Research Methods**  
*Prerequisite: 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. Doctoral students only or by permission of instructor. (Fall)

**ED 506. Concepts and Issues in Social Science Research**  
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). Doctoral students only or by permission of instructor. (Fall and Summer B)

**ED 507. Qualitative Research Methods**  
*Prerequisite: ED 506.*  
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. Doctoral students only or by permission of instructor. (Spring and Summer B)

**ED 520. Program Evaluation**  
*Prerequisites: ED 506 for doctoral students, ED 406 or equivalent for other students, ED 504 and ED 507 recommended.*  
Introduces students to the various approaches for evaluating educational and community programs. Program evaluation helps decision makers work with data to assess community needs, launch a new program, follow the progress of an existing program, and summarize program outcomes. Students complete a proposal for a program evaluation by the end of this course. Doctoral students or students in program evaluation certification or by permission of instructor (Fall and Summer A)

**ED 521. Advanced Program Evaluation**  
*Prerequisite: ED 520.*  
Guides students through the data collection, analysis, and reporting stages of a program evaluation. Doctoral students or students in program evaluation certification or by permission of instructor (Spring)

**ED 523. Mixed Research Methods**  
*Prerequisites: ED 506, 504, 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. Doctoral students only or by permission of instructor. (Fall, odd years)

**ED 524. Survey Design**  
*Credit—One hour*  
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 acquire practical knowledge and skills relating to survey design. (Fall, Spring, and Summer A)
ED 525. Interview and Focus Group Techniques  
Credit—one hour  
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. (Fall, Spring, and Summer A)

ED 527. Advanced Qualitative Research Methods  
Prerequisites: ED 506, 507.  
Builds on ED 507, Qualitative Research Methods, to provide a deeper examination of theory, method, and study design in qualitative research. Explores specific qualitative research methodologies as frameworks for understanding human activity. Students design a research project that is directly related to their dissertation topic. It is strongly recommended that students complete their comprehensive exams prior to this course. Doctoral students only. (Fall)

ED 528. Using Quantitative Data Analysis Software  
Prerequisite: ED 506 or concurrently. (Students with experience using software package may contact instructor to schedule an on-site proficiency exam to waive this prerequisite.)  
Credit—one hour  
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 focuses 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. 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.) (Fall and Summer A)

ED 529. Using Qualitative Data Analysis Software  
Prerequisite: ED 506.  
Credit—one hour  
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 N8 software packages, allowing students the opportunity to code text thematically, conduct basic qualitative analysis, and create coded reports. Occasionally the course focuses 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. (Occasionally)

ED 530. Doctoral Seminar: Grounded Theory in Qualitative Research  
Prerequisite: ED 507.  
Doctoral students only. (Summer A, occasionally)

ED 531. Case Study Design and Analysis  
Prerequisite: ED 506.  
Credit—one hour  
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. (Occasionally)

ED 532. Action Research Methods  
Credit—one hour  
Provides a theoretical and practical base for students to design a research project in their own educational work setting. (Fall)

ED 533. Research Strategies Series  
The Research Strategies series was created for students needing to bundle three 1-credit, mini-courses on specific research strategies (e.g., ED 525, 526, 528, 529, 531, 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. Open to doctoral students only or by permission of instructor. (Fall, Spring, and Summer A and B)

ED 581. Discourse Analysis in Education Research  
Prerequisites: ED 506, 507, and permission of instructor.  
Discourse analysis has become a key analytic lens in educational research. This course introduces students to discourse analysis as a research methodology and analytic framework for the examination of language in use. The course is intended to provide students with opportunities to discuss central theoretical issues in discourse analysis and to provide opportunities to work with language data in order to develop students’ analytic skills and to receive critical feedback on their work. The course is intended for advanced doctoral students who have taken introductory research methods courses and in particular, those with an interest in learning about discourse analysis to advance their own research. 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. The course introduces students to discourse analysis from the following theoretical positions: linguistic anthropology, critical discourse analysis, and sociolinguistics. (Occasionally)
INDEPENDENT WORK

Warner School students in all doctoral programs and some master’s programs can benefit from the opportunity to study topics of interest to them under the supervision of a faculty member. Depending on the type of independent work, students are expected to register for one of the following courses (students must identify the faculty member that has agreed to supervise the work and the number of credits agreed upon).

ED 491. Independent Study in Education—Master’s Level
Prerequisite: permission of instructor.
Credit—varies
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. (Fall, Spring, and Summer)

ED 492. Field Study in Education—Master’s Level
Credit—varies
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. (Fall, Spring, and Summer)

Prerequisite: agreement of thesis sponsor.
Credit—varies
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. (Fall, Spring with a seminar option, and Summer)

ED 496. Research Apprenticeship—Master’s Level
Prerequisite: permission of instructor.
Credit—varies
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). (Fall, Spring, and Summer)

ED 591. Independent Study in Education—Doctoral Level
Credit—varies
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. Doctoral students only or by permission of instructor. (Fall, Spring, and Summer)

ED 592. Field Study in Education—Doctoral Level
Credit—varies
This option can be used by doctoral students who are interested in engaging in a supervised project or field experience relevant to their program. Doctoral students only or by permission of instructor. (Fall, Spring, and Summer)

ED 593. EdD Research (Dissertation)
Credit—varies
EdD 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. (Fall, Spring, and Summer)

ED 595. PhD Research (Dissertation)
PhD 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. (Fall, Spring, and Summer)

ED 596. Research Apprenticeship—Doctoral Level
Credit—varies
This course, required for PhD students, is designed to apprentice novice scholars in a variety of research practices. Students participate in an existing research project directed by a Warner faculty member (with permission and under the supervision of that faculty member). The research apprenticeship is a requirement for all PhD students but is open to other Warner students as well. Doctoral students only or permission of instructor. (Fall, Spring, and Summer)

Inclusion
EDE 445. Teaching Students with Significant Disabilities
The purpose of this course is to prepare 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. Candidates should be able to identify systemic structures that impede student learning and develop advocacy skills to break down these barriers. (Fall)
EDF 445. Field Experiences with Students with Significant Disabilities
Prerequisite: EDE 445 (concurrently).
(Fall)

ED 448. Behavior and Communication Supports for Students with Significant Disabilities
This course is designed to develop 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. The class 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. Laws and regulations affecting the education and inclusion of all students are addressed. Family issues, the inclusion/standards debate, assessment, and labeling, as well as other issues facing schools are addressed. There are 20 additional field hours attached to this course. (Summer B)

ED 453. Post-Secondary Transition for Youth with Significant Disabilities
This course is designed to develop a context for current and pre-service teachers to understand the needs of secondary students with low-incidence disabilities. The course 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. (Spring)

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. (Spring)

ED 416. Aggression, Human Development, and Youth: Theory, Social/Cultural Contexts, Prevention, and Intervention
Designed for practitioners, this course has been created for those who grapple with problems caused by aggression, whether it is in the fields of nursing, education, public health, social work, or counseling. This course is organized around three main strands: theory, practical issues, and prevention/intervention. The first part of the course explores explanations of aggression including evolutionary, psychological, sociological, and epigenetic theories. The second part of the course considers the contextual and cultural manifestations of aggression including school violence (i.e., classroom management, bullying, the use of punishment, and sexual harassment), family and interpersonal aggression (i.e., domestic and intimate partner violence, dating aggression, child physical and sexual abuse, and elder abuse), sports/athletics and aggression (including hazing), community violence and gangs, and microaggressions and issues of race, ethnicity, and gender. The third part of the course considers prevention and intervention programs and approaches that are designed to address these issues, with the goal being the development of class participants who can be wise consumers of programs and approaches. To that end, course participants study a variety of programs and approaches, their theoretical groundings, their goals, their implementation mechanisms, and their evaluated outcomes. Finally, aggression within the context of life course theory is considered as a way to frame a broader conversation about aggression and human development. (Occasionally)

ED 417. Crisis Counseling and Disaster Mental Health
Prerequisite: EDU 450 or 472.
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. Restricted to counseling students or other mental health professionals (with permission of instructor). (Fall and Spring)

ED 418. The Family and Social Dynamics
Introduces the basic dimensions and dynamics of the family as a social institution and as a significant context for individual development. Explores the nature and dimensions of the institution of the family across cultures and history; alternative
ED 419. Life Course Studies
Examines the popular myths and misunderstandings about aging and the life course by critically surveying existing scholarly knowledge, research, and theory about the life course and examining how the individual’s biographical experience and view of his or her personal past and future are shaped both by societal institutions and interpersonal expectations. (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. (Fall)

EDE 423. Spirituality, Religion, and Healing in Counseling
Introduces students to the practice of integrating religion, spirituality, and healing into the humanistic counseling/therapeutic relationship. Surveys the current issues pertaining to the assessment and treatment of clients incorporating religious and spiritual constructs, including the various religious worldviews, an understanding of the psychological development of religious and spiritual perspectives, the treatment of religious and spiritual dysfunction, the incorporation of religious and spiritual assets, the spiritual and healing aspects of the body and mind connection, the connection of spirituality with the creative process, and a review of the clinical research in this particular aspect of the counseling field. Open to counseling students or by permission of instructor. (Summer A, even years)

ED 425. Minority Youth Development in Urban Contexts
Provides an exploration of developmental and sociocultural processes that impact long-term outcomes for minority students. Examines influential environmental issues that focus on cultural, educational, structural, and sociopolitical factors. Students acquire an understanding of how these influences (e.g., racial socialization, parental stressors, and residential segregation) can impact development for minority children and how this knowledge can inform intervention strategies. (Spring)

ED 429. Theories of Human Development
Provides a comprehensive introduction to multidisciplinary approaches to human development within the behavioral and social sciences. Explores theories of human development and the process of individual change over time that occurs in social, cultural, and historical contexts. Examines central theories of transformation and development that explain human behavior, the environmental factors that affect both normal and abnormal behavior, and the systems (e.g., school, family, and community) that interact to affect an individual’s development. (Fall and Summer A)

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 are 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 relationships to each other. (Fall)

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. (Fall)

EDU 450. Introduction to School Counseling
Introduces the counseling profession with an emphasis on the counselor’s role in educational settings. Examines the responsibilities of the counselor from a historical, theoretical, and practical point of view. Explores the helping relationship, the roles of the school counselor, and the professional practice issues related to providing school counseling services in historical and contemporary settings. Focus is placed on the fundamental elements of basic listening and communication skills that serve as the building blocks for more advanced counseling skills. Open to students who are not matriculated in the counseling program, with permission of instructor. (Fall)

EDF 453. Practicum in Applied Behavioral Analysis
(Most semesters)

EDU 453. Counseling and Facilitating in Small Groups
Prerequisite: EDF 450.
Explores the dynamics of small groups and their application to the work of counselors and other helping professionals. 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. Open to students who are not matriculated in the counseling program with permission of instructor, if space is available. (Fall, Spring, and Summer B)

**EDE 454. Assessment and Treatment of Challenging Behaviors**  
*Prerequisite: ED 453.*

Applied behavior analysis has a robust history and literature pool addressing analysis of and intervention for challenging behavior. This course provides an overview of the field’s history and evolution in the assessment and treatment of challenging behavior and provides the student opportunities to apply current best practice. The foci of this course include (1) the identification of challenging behavior and applicable assessment procedures, (2) fundamental elements of behavior change procedures, (3) selecting intervention and outcome procedures, and (4) behavior change systems. (Summer)

**EDU 454. Career Counseling and Development**

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. Open to students who are not matriculated in the counseling program, with permission of instructor. (Spring and Summer A)

**EDE 455. Research Methods in Applied Behavior Analysis**  
*Prerequisite: 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 provides students a thorough overview of applied behavior analysis research methods and “guides” students through the process of developing a (hypothetical) applied behavior analytic research project. (Spring)

**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, lifelong, and multidisciplinary 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. (Fall)

**EDE 456. Ethical and Professional Conduct for Behavior Analysts**  
*Prerequisite: ED 453 or concurrently.*

The profession of behavior analysis is undergirded by stringent 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. The foci of this course include (1) best professional practice in presentation, application, and influence; (2) a thorough review of the Guidelines for Responsible Conduct in light of professional practice; and (3) ethical practices and their significance in light of examples of ethical dilemmas from the text, professional writings, and student and professor professional experience. (Fall)

**EDE 457. Staff Training and Performance Management**  
*Prerequisite: ED 453.*

The foci of this course include (1) training professionals and paraprofessionals working in treatment, education, and other settings; (2) analysis of treatment and educational systems, including systems management; (3) supervision of treatment and educational staff and in business and industry; and (4) the analysis of training and supervision interventions and their effect on consumer (client/student) outcomes and work environments. (Spring)

**EDU 457. Counseling Theory and Practice I**  
*Prerequisite: 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. Analyzes professional issues, such as professional organizations, licensure, counseling ethics, and multicultural competence and awareness. Introduces basic interviewing and counseling skills and integrates theoretical approaches with skill development for counseling practice. Open to students who are not matriculated in the counseling program, with permission of instructor. (Fall)

**EDU 459. Contemporary Issues in School Counseling**  
*Prerequisites: EDF 450, 451 concurrently.*

Reviews a wide array of current issues and strategies for school counseling, including child abuse and mandated reporting; legal and ethical issues; working with multicultural, diverse, and special populations; and the counselor’s role in responding to eating disorders, drug and alcohol abuse, teen pregnancy, violence, and more. The course entails lectures, class discussions, and in-class/extra-class projects that combine knowledge in many disciplines with self-understanding and perceptive abilities. Matriculated counseling students only. (Fall)
**EDU 460. Counseling Theory and Practice II**  
Prerequisite: EDU 457.

A continuation of Counseling Theory and Practice I. Enhances counseling and communication skills and knowledge of the counseling relationship, as well as strategies for crisis intervention. Prepares and supports students in their Practicum in Counseling (EDU 458), which may be done concurrently. Matriculated counseling students only. (Fall)

**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. Open to students who are not matriculated in the counseling program, with permission of instructor, if space is available. (Fall and 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-IV-TR are introduced, and opportunities are provided to make diagnostic assessments and treatment planning strategies through the use of confederate case clients. DSM-IV-TR categories covered include mood disorders, anxiety disorders, personality disorders, and disorders usually first diagnosed in infancy and childhood. Matriculated counseling students only. (Fall)

**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. Open to students who are not matriculated in the counseling program, with permission of instructor. (Spring and Summer A)

**EDU 471. Counselor as Systems Consultant**  
Prerequisites: EDU 453, EDF 450 or concurrently.

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. Matriculated counseling students only. (Fall)

**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. Open to students who are not matriculated in the counseling program, with permission of instructor. (Fall)

**EDU 473. Problem Identification and Intervention in Counseling II**  
Prerequisite: EDU 466.

A continuation of Problem Identification and Intervention in Counseling I. Students are introduced to additional Diagnostic and Statistical Manual of Mental Disorders-IV-TR categories, including dissociative disorders, dementia, schizophrenia and other psychotic disorders, eating disorders, factitious disorders, and sexual and gender identity 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. Matriculated counseling students only. (Spring)

**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. Open to students who are not matriculated in the counseling program, with permission of instructor. (Spring)

**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 explores its use in counseling with children, adolescents, adults, and elders. This course consists of experiential activities and didactic learning experiences. (Summer A, odd years)
EDU 479. Promoting Mental Health in Midlife and Old Age
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 and changing identity, increasing dependency, loneliness, death and dying, and structural ageism. Attention is given to DSM-IV-TR 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 later life. Other topics germane to later life are explored, including assisted living, long-term care, and elder abuse. Open to students who are not matriculated in the counseling program and human development gerontological concentration, with permission of instructor. (Spring, odd years)

EDU 494. Human Development in Old Age
Examines aging as a dynamic complex shaped by sociocultural and political processes that include issues of gender, ethnicity, social status, life experience, sexual orientation, and health/illness. Sociocultural ecologies of aging, such as families, communities, and societies, are explored relative to developmental needs and resources. Introduces participants to a spectrum of community resources involved in supporting well-being in old age. (Spring, even years)

EDU 549. Contemporary Learning Theories
Explores the meaning of the construct “learning” and its relation to the construct “development.” Behaviorist learning theory is briefly reviewed, including the ways that it is still a guiding force in educational settings. A variety of more contemporary theories and views of learning are considered, including those that have emerged from research in laboratory, naturalistic, and formal educational settings. These include neo-nativist views, activity theory, situated learning, communities of learners, anchored instruction, and the relations between learning and motivational factors. Emphasizes learning as an active process in pursuit of personally meaningful goals and the appropriate roles adult guidance plays in the learning process. Doctoral students only, or by permission of instructor. (Spring, even years)

EDU 552. Counselor Education
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 counselor education and practice instructional skills. Enrollment limited to matriculated doctoral degree candidates in the counseling program or by permission of instructor. (Fall, even years)

EDU 553. Counselor Supervision
Introduces the field of counselor supervision and 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. Enrollment limited to matriculated doctoral degree candidates in the counseling program or by permission of instructor. (Spring)

EDU 554. Advanced Theory, Research, and Practice in Group Work
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. Enrollment limited to matriculated doctoral degree candidates in the counseling program or by permission of instructor. (Spring, odd years)

EDU 555. Comprehensive Exam Research: Counseling and Human Development PhD
(Fall, Spring, and Summer)

EDU 555. Advanced Counseling Theory, Research, and Practice
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. Enrollment limited to matriculated doctoral degree candidates in the counseling program or by permission of instructor. (Spring, even years)

EDU 556. Comprehensive Exam Research: Counseling and Human Development EdD
(Fall, Spring, and Summer)

EDU 557. Selected Theories of Human Development
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.

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.” Doctoral students only or by permission of instructor. (Spring, odd years)

EDU 561A. Counseling and Human Development Doctoral Cohort Seminar 1A
Designed to support students enrolled in the first two years of the accelerated EdD 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 meet frequently in the second year. Counseling and human development accelerated EdD students only. (Summer)

**ED 561B. Counseling and Human Development Doctoral Cohort Seminar 1B**

Designed to support students enrolled in the first two years of the accelerated EdD 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 are held frequently in the second year. Counseling and human development accelerated EdD students only. (Fall)

**ED 561C. Counseling and Human Development Doctoral Cohort Seminar 1C**

Designed to support students enrolled in the first two years of the accelerated EdD 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 are held frequently in the second year. Counseling and human development accelerated EdD students only. (Spring)

**ED 562A. Counseling and Human Development Doctoral Cohort Seminar 2A**

Designed to support students enrolled in the first two years of the accelerated EdD 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 are held frequently in the second year. Counseling and human development accelerated EdD students only. (Spring)

**ED 562B. Counseling and Human Development Doctoral Cohort Seminar 2B**

Designed to support students enrolled in the first two years of the accelerated EdD 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 are held frequently in the second year. Counseling and human development accelerated EdD students only. (Fall)

**ED 562C. Counseling and Human Development Doctoral Cohort Seminar 2C**

Designed to support students enrolled in the first two years of the accelerated EdD 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 are held frequently in the second year. Counseling and human development accelerated EdD students only. (Spring)

**ED 563. Counseling and Human Development Dissertation Proposal Seminar**

Provides support to accelerated EdD 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 also provided. Counseling and human development accelerated EdD students only. (Summer)

**EDU 563. Advocacy, Consulting, and Systems Change as Counseling and Human Development Practice**

Situates 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. Includes basic principles of program evaluation. Enrollment limited to matriculated doctoral degree candidates in the counseling and human development programs or by permission of instructor. (Fall, odd years)

**EDU 564. Counseling and Human Development Dissertation Seminar I**

*Prerequisite: ED 563.*

Provides ongoing support to accelerated EdD students as they work through the various aspects of collecting, analyzing, and interpreting their dissertation data. Counseling and human development accelerated EdD students only. (Fall)

**EDU 564. Contemporary Trends in Mental Health, Appraisal, Intervention, and Research**

Familiarizes students with contemporary approaches to appraisal and intervention in mental health practice and introduces them to relevant “cutting-edge” trends in research. Students learn a number of contrasting diagnostic paradigms, study a range of clinical problems and disorders, and learn a diversity of intervention options. Students develop further understandings of the DSM-IV-TR, multiculturally appropriate assessment instruments, and intervention alternatives. Enrollment limited to matriculated doctoral candidates in the counseling and human development program or by permission of instructor. (Fall, odd years)
ED 565. Counseling and Human Development Dissertation Seminar II
Prerequisite: ED 564.
Provides ongoing support as accelerated EdD students write and complete the dissertation and prepare for the oral defense. Counseling and human development accelerated EdD students only. (Spring)

EDU 565. Research in Life Course Studies
Considers macro- and micro-systemic process in the study of the human life course. Individual outcomes are understood in the context of population-level dynamics. Particular attention is given to social, cultural, and historical factors in shaping individual developmental trajectories. Students are encouraged to reflect on their own life course development. Enrollment limited to matriculated Warner doctoral candidates in the counseling and human development programs or by permission of instructor. (Fall, even years)

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. Doctoral students only or permission of instructor. (Spring, odd years)

Clinical Experiences
Students in most counseling programs are required to complete a series of practicums and/or internships. The nature and duration of these internships is determined by the specific program and specialization sought, although all internships include a combination of work at an internship site consistent with the chosen area of specialization, individual and group supervision, and attendance at weekly University seminars. Internships take place in a fall/spring sequence at the end of the program, unless otherwise indicated. Enrollment is limited to matriculated master’s or doctoral degree candidates in the appropriate counseling program or by permission of the department chair.

EDF 450. Practicum in Counseling
Prerequisites: EDU 450, EDE 449, EDU 457, 460 or concurrently.
Develops and improves counseling skills with clients and groups and observes the action of social systems in a real-world environment in this introductory on-site practicum experience in a school or community setting. Students work at the site, tape counseling sessions, receive individual and group supervision, and attend a weekly University class. Practicum in Counseling is a prerequisite to all other internships. Enrollment limited to matriculated master’s degree candidates in the counseling program. (Spring)

Counseling Internships
The following courses are counseling internships. EDF 450 is a prerequisite to all other master’s counseling internships.

EDF 451. Supervised Internship in School Counseling I
Credits—three hours
(Fall)

EDF 452. Supervised Internship in School Counseling II
Credit—three hours
(Spring)

EDF 458. Supervised Internship in Community Mental Health Counseling
Credit—one–six hours
(Fall, Spring, and Summer)

Doctoral Level
EDF 558. Supervised Internship in Counselor Education I (Doctoral)
Credit—three hours
(Fall and Spring)

EDF 559. Supervised Internship in Counselor Education II (Doctoral)
Credit—three hours
(Fall and Spring)

EDF 560. Supervised Internship in Mental Health Counseling (Doctoral)
Credit—one–six hours
(Fall, Spring, and Summer)

Inclusion
ED 453. Introduction to Applied Behavior Analysis
This course addresses the foundational principles and methods in applied behavior analysis, and their basic and general application. (Fall)

ED 458. Methods and Applications in Applied Behavior Analysis
Prerequisite: 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. (Spring)

ED 459. Practicum in Applied Behavior Analysis and Autism Spectrum Disorders I
Prerequisites: ED 453, 457, 458.
Through supervised experience at approved practicum sites, students learn how to apply knowledge of behavioral approaches to the education of children with autism spectrum disorders.
Students work as part of a collaborative team to implement IEP goals and objectives and to problem solve for student learning or behavioral difficulties. Open only to students admitted to the Autism Spectrum Disorders Certificate Program. (Fall and Spring)

**ED 460. Practicum in Applied Behavioral Analysis and Autism Spectrum Disorders II**
Prerequisites: ED 453, 457, 458, 459.

Through supervised field-based experience, candidates learn to apply knowledge of behavioral approaches to the education of children with autism spectrum disorders. Candidates work as part of a collaborative multidisciplinary team to implement IEP goals and objectives and to problem solve for student learning or behavioral difficulties. Supervision is provided by behavioral psychologists or behavior analysts. (Spring)

**EDUCATIONAL LEADERSHIP COURSES**

**EDU 404. School Leadership in Diverse Settings**
Given the increased diversity in American public schools, this course provides a historical and contemporary examination of how race and socioeconomic status affect the educational opportunities, experiences, and outcomes of students in elementary, secondary, and postsecondary institutions. Exploring the challenges students of color and the poor confront in the pursuit of quality education, the course grapples with how school leaders are in a position to create the conditions necessary to foster success. Focuses on the structural, cultural, and psychological factors that affect the response of students in schools. Investigates how notions of racial and socioeconomic diversity and associated attributes often place students at a disadvantage in U.S. schools. Explores how schools can positively impact students from these communities. (Spring)

**EDU 407. Curricular and Instructional Leadership**
Provides an overview of critical leadership issues related to curriculum policy and classroom practice. Explores the "coherent curriculum" and the many complex layers involved in creating, implementing, and assessing the connectedness among everyday educational experiences. Reflects on the role of educational leaders in creating and shaping learning communities. Develops leadership practices and strategies that build a healthy learning climate by focusing on applying theory to practice; develops authentic contexts for learning; uses results to inform decisions; creates successful learners; and generates enthusiasm for rich learning experiences. (Spring and Summer B)

**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. (Fall, even years)

**ED 413. Student Affairs Administration: Academic Support Services**
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. (Summer, even years)

**EDU 413. Contemporary Issues in Education Policy**
Introduces students to several currently pressing educational policy issues and debates, including class size reduction, school choice, and teacher recruitment and retention. Provides content knowledge and encourages 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. Focuses on the impact recent policies have had on the public school system, the school organization, educational performance, and equity. Open to graduate-level students or by permission of instructor. (Fall)

**EDU 416. Conflict Management in Schools and Universities**
Provides emerging educational leaders with effective conflict management skills to optimize the daily performance of faculty, staff, and students to solve problems, make the best decisions, and achieve educational goals. Examines the theoretical underpinnings of conflict resolution, the practice of skills, and the identification of dispositions necessary for successful collaboration, negotiation, and mediation in schools and universities. (Spring)

**EDU 418. Leadership in Education**
Introduces and surveys the theory and research on leadership and what leaders in educational organizations do. Develops leaders’ abilities to analyze problems in education and apply successful leadership approaches to them and to successfully lead an educational organization. (Fall, even years)

**ED 421. Reform in Public Schools**
Examines how federal, state, and local reform efforts impact teaching and learning, focusing on implications for administrators, teachers, and students in American public schools. Evaluates past and current large-scale strategies to transform the organizational, curricular, and instructional capacity of schools. Considers whether such changes have improved student access, engagement, and outcomes. The influence of race, class, and gender is addressed. Topics covered include Title I, comprehensive school reform, standards-based education, and high-stakes testing. (Fall)

**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 and on policies and procedures for sound personnel administration practice. (Fall)
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. (Fall, even years)

ED 433. Student Affairs Administration: Admissions and Financial Aid
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 complement class offerings. (Summer, odd years)

ED 434. Student Affairs Administration: Minority Student Affairs
With changing demographics and institutional emphasis on promoting diverse student populations, support services for minority students have emerged in higher education administration. This course focuses on the history, underlying philosophies, organizational structures, and professional staffing in minority student affairs. In addressing current issues and future challenges facing such organizations, topics explore the complexity of racial identity; offer reflections on Brown v. Board of Education; and illuminate why affirmative action in higher education is necessary to achieve diversity. Guest presentations by practicing professionals may complement class offerings. (Occasionally)

ED 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. (Fall)

ED 437. Diversity and Equity in Higher Education
Examines the educational history of nondominant populations. Critical race theory is used to explore the institution of higher education. While race and gender are broad topics, these issues are complicated with those of class, disability, power, and our role in the power structure. Critical multiculturalism provides the basis for transformation in higher education. (Spring)

ED 439. Policy Analysis in Education
Focuses on the fundamental principles of policy analysis with a review of literature from education, public policy, and political science. The major requirement for this course is a group project examining a substantive K–20 policy issue. (Spring)

ED 456. Leadership and Special Education
Examines federal and state laws, regulations, and critical issues regarding the education of students with disabilities. Explores the implications for policy and practice these legal and ethical issues impose on districts, schools, and teachers. Issues of access, diversity accountability, including classification, placement, assessments, interventions, and professional development are explored. (Occasionally)

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. (Spring, odd years)

ED 462. Managing School Resources
Provides students with the skills needed to manage school resources (both fiscal and physical) effectively. Prepares students to formulate 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. (Spring)

ED 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. Discussions include the No Child Left Behind Act, charter school policies, class-size reduction policies, and issues related to high-stakes testing. (Spring, even years)

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. (Spring)

ED 466. Leading Change in Schools
Examines issues of leadership and change in education and the many sources of pressure on schools to change. Prepares developing school leaders to identify situations that require change and
the skills needed to make change happen. Applying the ideas of change theorists, including Lewin, Senge, and Kotter, to educational problems is the foundation of this course. (Occasionally)

**EDE 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. (Spring)

**ED 467. Student Affairs Administration: International 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. (Summer, even years)

**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 are made available during and outside of course meetings. (Summer A)

**EDU 468. Data-Driven School Improvement**

School leaders work in a climate that increasingly stresses the role of data collection and analysis as vital tools in decision making. Stakeholders, including parents, faculty, board members, state and federal governmental agencies, and the press, rely on data reporting to judge the quality of school programs. In this course, students are instructed on how to plan, design, implement, and complete an evaluation of an educational program using student achievement data. (Fall)

**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. (Summer A)

**ED 470. Leading Effective Program Design**

Develops skills and strategies that educational leaders need to become effective program designers. Examines research on instructional theory and practice as connected to improving student achievement. Prepares leaders to address current reform issues through consistent, systemic K–12 program design. Explores the use and application of curricular and instructional analysis. Participants design educational programs to meet the needs of specific student populations. (Occasionally)

**ED 475. Leadership and Management in Higher Education**

Assists those in higher education in understanding different leadership and management approaches in the context of the academy. Opens with an overview of theory associated with leadership and management and then applies major theoretic constructs to higher education. The course delves into application of leadership and management ideas for students, both for their development and management. Examines in detail administration leadership in an effort to shed light on the roles of different leadership approaches in generating socially just institutions of higher education. (Spring)

**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. (Fall)

**ED 477. 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. (Spring, occasional odd years)

**EDE 479. Assessment, Accreditation, and Accountability in Higher Education**

The determination of quality in education is an omnipresent issue, and this course examines how quality is being examined in contemporary higher education. This hybrid summer course begins by examining historic and contemporary accreditation processes in U.S. higher education in comparison to international quality assurance efforts and then turns to the examination of how assessment and accountability are being employed in relationship to understanding and enhancing educational quality. The final product of the course is an individual assessment plan that aids each student's exploration of quality in a given organizational entity in higher education.
ED 480. Contemporary Issues in Student Affairs
Explores contemporary issues in student affairs in higher education. Students explore issues impacting the practice of student affairs such as globalization, accountability, finances, and today’s diverse student. The role of professional organizations is also addressed.

ED 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. (Fall, odd years)

ED 482. Introduction to Fundraising in Higher Education
Provides a comprehensive look at the principles and components of advancement in higher education. Delves deeply into each of the components of advancement and provides students with hands-on learning experiences through readings, case studies, and creative projects. Provides students with a full understanding of all the different aspects of advancement necessary to plan and execute comprehensive campaigns. By the end of the course, students have full mastery of the components and principles of university advancement and are equipped to contribute to the profession, both practically and theoretically. (Fall)

ED 483. Leadership and Management Competencies for Higher Educational Advancement Administrators
Explores a variety of management approaches and encourages students to use real-life examples from their workplace to enhance discussions, projects, and assignments. Aims to provide students with competencies and knowledge about people management and leadership within the university advancement context. This course is designed for advancement administrators who seek to learn the theoretical foundations of people and organizational management as well as a practical application of the theory. (Spring, occasionally)

ED 484. Student Affairs Administration: Residential Life
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. (Summer, even years)

ED 485. College Students and Student Development Theory
Explores psychosocial, cognitive-structural, identity, and typology theories of college student development. Discusses examples of application and use of student development theory in everyday student affairs practice. Drawing from current research in the field of higher education, this course provides information about the behavior and trends related to American college students. (Spring)

ED 485. Student Affairs Administration: Student Activities and Fraternity/Sorority Affairs
Two critical, visible, intense, and often intertwined areas of higher education administration are student activities and Greek affairs. 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 complement class offerings. (Summer, odd years)

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 is paid to the sociocultural context, particularly on the role of families. (Fall)

ED 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. (Spring, even years)

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. (Spring, odd years)

ED 491. The Entrepreneurial University
This course is a critical examination of the emerging entrepreneurial university. Examines five generations of university history, including the emerging entrepreneurial context. Also examines the following major topics: university responses to fiscal resource tensions; advancement; technology transfer; changing faculty behavior and governance; the role of the university in globalization; entrepreneurial leadership and action; assessment and accountability; and development and shifting curriculum (e.g., entrepreneurial education). (Summer, occasionally)
**EDU 492. Governance, Policy, and Administration of Higher Education**

Examines the organization and governance of American higher education institutions, giving due weight to the context in which trustees, presidents, academic administrators, and faculty members make decisions. (Spring)

**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. (Fall, even years)

**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. (Fall, odd years)

**EDU 502. Leading the School District: The Superintendency in the 21st Century**

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. (Summer 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. (Fall, odd years)

**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. (Fall)

**EDU 516. Decision Making for Educational Leaders II: Making Decisions in Schools and Universities**

Prerequisite: 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. (Spring)

**EDE 538. Educational Policy Seminar**

Prerequisite: ED 505 or completion of one or more policy courses.

Examines select educational policy issues in greater depth. The topics covered are determined by the instructor’s and students’ interests. Much focus of educational policy since Brown v. Board of Education has focused on addressing racial, socioeconomic, and linguistic gaps in school outcomes. This course examines the various factors that students confront within schools and communities that contribute to educational inequities. This course examines the potential and limitations of local, state, and federal policies to adequately address educational disparities in K–12 schools. The course considers how broader social policies (i.e., economic and health policy) that aim to improve the social support systems in local communities can aid with increasing educational outcomes. Doctoral students only or by permission of instructor. (Occasionally)

**ED 540. Program Evaluation Dissertation Proposal Seminar**

Prerequisite: ED 550 or EDE 551.

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, 541, and 542. Open to students in the educational leadership accelerated EdD program only. (Summer)

**ED 541. Program Evaluation Dissertation Seminar I**

Prerequisite: ED 540.

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, 541, and 542. Open to students in the educational leadership accelerated EdD program only. (Fall)

**ED 542. Program Evaluation Dissertation Seminar II**

Prerequisite: ED 541.

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, 541, and 542. Open to students in the educational leadership accelerated EdD program only. (Spring)
ED 543. Decision Making Dissertation Seminar I  
*Prerequisite: ED 546, permission of an instructor required.*

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, 543, and 544. Open to students in the educational leadership accelerated EdD program only. (Fall)

ED 544. Decision Making Dissertation Seminar II  
*Prerequisite: ED 543.*

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, 543, and 544. Open to students in the educational leadership accelerated EdD program only. (Spring)

ED 545. Program Evaluation Practicum  
*Prerequisites: ED 520, 521.*

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. Open to doctoral students only. (Fall, Spring, and Summer)

ED 546. Decision Making Dissertation Proposal Seminar  
*Prerequisite: ED 550 or EDE 551.*

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 thesis involving a decision making project that includes ED 546, 543, and 544. Open to students in the educational leadership accelerated EdD program only. (Summer)

ED 550. Qualifying Case Analysis Educational Administration  
*Prerequisite: 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). (Summer A)

EDE 551. Comprehensive Exam Research: Higher Education EdD  
*Prerequisite: completion of EdD coursework.*

Provides evidence that EdD 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. Open to students in the higher education EdD program only. (Fall, Spring, and Summer)

EDE 552. Comprehensive Exam Research: Educational Leadership, K12 Administration PhD  
(Fall, Spring, and Summer)

EDE 553. Comprehensive Exam Research: Higher Education PhD  
(Fall, Spring, and Summer)

EDE 554. Comprehensive Exam Research: Educational Policy and Theory PhD  
(Fall, Spring, and Summer)

EDE 560. Portfolio Review: Educational Leadership  
(Fall, Spring, and Summer)

ED 570. Dissertation Creation Seminar  
*Prerequisites: ED 504, 507, completed or near complete comprehensive exams.*

Prepares doctoral students for the process of writing their dissertation proposals. Provides students with the skills necessary to critically evaluate the design of published research in the field of higher education and in their respective areas of expertise. In addition to building upon the knowledge gained in students’ methods courses, this course pays particular attention to the use of conceptual and theoretical frameworks in research design. This course is open to students in the PhD and traditional EdD higher education programs. Students who have completed their methods courses and comprehensive exams and who are at, or near, the proposal stage of their doctoral programs may enroll in this course. This course is not open to master’s students or doctoral students in the accelerated dissertation cohorts. Students’ final course assignment will include a draft of their dissertation proposal. Enrollment in the course must be approved by the instructor(s). (Occasionally)

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. (Fall)
Internships
The following internships can take place in any semester under the supervision of a faculty member in educational leadership. Each internship needs to be individually arranged through the faculty advisor(s) involved and the cooperating educational organization.

**EDF 497. Supervised Internship in Higher Education**
*Credit—varies*
Directed and supervised experiences in a higher education setting. (Fall, Spring, and Summer)

**EDF 498. Supervised Internship in Educational Administration**
*Credit—varies*
Directed and supervised experiences at both the building and district level for the equivalent of 15 weeks’ full time, as necessary to meet the new New York State requirements for administrative certification and NCATE standards. Includes participation in regular university seminars. Required of students matriculated after September 2006 who are seeking New York State administrative certification. (Fall, Spring, and Summer)

TEACHING AND CURRICULUM COURSES

**EDF 410E. Field Experiences in Middle Childhood (English)**
*Prerequisite: EDU 431.*
Preservice teachers taking EDU 431 only. (Fall)

**EDF 410F. Field Experiences in Middle Childhood (Foreign Languages + Latin)**
*Prerequisite: EDU 435.*
Preservice teachers taking EDU 435 only. (Fall)

**EDF 410H. Field Experiences in Middle Childhood (Social Studies)**
*Prerequisite: EDU 432.*
Preservice teachers taking EDU 432 only. (Fall)

**EDF 410M. Field Experiences in Middle Childhood (Math)**
*Prerequisite: EDU 436.*
Preservice teachers taking EDU 436 only. (Fall)

**EDF 410S. Field Experiences in Middle Childhood (Science)**
*Prerequisite: EDU 434.*
Preservice teachers taking EDU 434 only. (Fall)

**EDF 411E. Field Experiences in Inclusive Middle Childhood Settings (English)**
*Prerequisites: EDU 431, ED 447.*
Preservice teachers taking EDU 431 only. (Fall)

**EDF 411F. Field Experiences in Inclusive Middle Childhood Settings (Foreign Languages + Latin)**
*Prerequisites: EDU 435, ED 447.*
Preservice teachers taking EDU 435 only. (Fall)

**EDF 411H. Field Experiences in Inclusive Middle Childhood Settings (Social Studies)**
*Prerequisites: EDU 432, ED 447.*
Preservice teachers taking EDU 432 only. (Fall)

**EDF 411M. Field Experiences in Inclusive Middle Childhood Settings (Math)**
*Prerequisites: EDU 436, ED 447.*
Preservice teachers taking EDU 436 only. (Fall)

**EDF 411S. Field Experiences in Inclusive Middle Childhood Settings (Science)**
*Prerequisites: EDU 434, ED 447.*
Preservice teachers taking EDU 434 only. (Fall)

**EDE 413. Seminar in Teaching Chinese**
*Prerequisite: concurrent with EDU 435.*
*Credit—none*
Student teaching seminar for students who are NOT doing practical through the Warner School but already teaching. (Fall)

**EDE 434A. Literacy Teaching: Urban Settings**
This optional internship provides an opportunity to experience teaching literacy in an urban setting. Under the supervision of Warner faculty and working directly in the classroom, interns work with elementary students at Henry W. Longfellow School #36 in the Rochester City School District. Interns help support student literacy learning in a multitude of ways, including selecting and interpreting appropriate assessment and diagnostic tools; determining student strengths and learning styles; developing individualized literacy plans; planning and implementing meaningful, engaging, culturally relevant lessons; choosing a wide variety of appropriate literacy resources and materials; and providing strategic, appropriate literacy intervention. Interns have an opportunity to apply their knowledge of theory and research in a practical setting; gain experience in providing reading, writing, and word study instruction within a balanced literacy framework; 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. (Fall)

**EDE 434B. Literacy Teaching: Urban Settings**
This optional internship provides an opportunity to experience teaching literacy in an urban setting. Under the supervision of Warner faculty and working directly in the classroom, interns work with elementary students at Henry W. Longfellow School #36 in the Rochester City School District. Interns help support
student literacy learning in a multitude of ways, including selecting and interpreting appropriate assessment and diagnostic tools; determining student strengths and learning styles; developing individualized literacy plans; planning and implementing meaningful, engaging, culturally relevant lessons; choosing a wide variety of appropriate literacy resources and materials; and providing strategic, appropriate literacy intervention. Interns have an opportunity to apply their knowledge of theory and research in a practical setting, gain experience in providing reading, writing, and word study instruction within a balanced literacy framework 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. (Spring)

EDE 434C. Literacy Teaching: Urban Settings

This optional internship provides an opportunity to experience teaching literacy in an urban setting. Under the supervision of Warner faculty and working directly in the classroom, interns work with elementary students at Henry W. Longfellow School #36 in the Rochester City School District. Interns help support student literacy learning in a multitude of ways, including selecting and interpreting appropriate assessment and diagnostic tools; determining student strengths and learning styles; developing individualized literacy plans; planning and implementing meaningful, engaging, culturally relevant lessons; choosing a wide variety of appropriate literacy resources and materials; and providing strategic, appropriate literacy intervention. Interns have an opportunity to apply their knowledge of theory and research in a practical setting, gain experience in providing reading, writing, and word study instruction within a balanced literacy framework 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. (Summer)

EDE 446. Introduction to Urban Education

Credit—one hour

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 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. Open to master’s students enrolled in UTL Program or with permission of instructor. (Summer A)

EDE 446. Inclusion Adolescence Student Teaching Seminar A

(Fall)

EDE 447. Inclusion Adolescence Student Teaching Seminar B

(Spring)

EDE 476. Teaching English Learners in Content Classrooms

Serves as an overview to teacher candidates and inservice teachers across content areas who work with English learners (ELs) during their teaching careers. Introduces students to the key concepts of language learning, cross-cultural communication, methods of teaching English, and testing and evaluation. Engages students in analysis, application, and adaptation of teaching methods, materials, and strategies to support instruction for linguistically and culturally diverse learners. (Summer B)

EDE 477. Topics in Teaching and Schooling, Part 2

Prerequisite: ED 400.

Introduces teacher candidates and inservice teachers to key issues in the teaching and learning of specific subject matters—with a particular focus on mathematics, science, and social studies. Identifies and critically examines key goals and approaches to the teaching of each subject matter, with an emphasis on making the learning of all subjects meaningful and accessible to every student. Engages course participants in innovative learning experiences, led by an expert in each subject matter, that model teaching methods as a way to deepen their understanding of key ideas as well as pedagogical approaches that are characteristic of each subject. Participants also engage in a critical examination of innovative K–12 classroom experiences, curricula, and instructional materials. The course is especially geared to “generalists” who are expected to support their students’ learning in all subjects but could also be valuable to teachers interested in interdisciplinary collaborations, education professionals playing a supporting role, and teacher candidates who want to explore alternative specializations before making a decision. (Fall)

ED 511. Introduction to Advanced Academic Literacy

Credit—one hour

This course introduces graduate students to the key role that the research literature plays in knowledge consumption and production at the graduate level. It helps students identify how to locate useful research relevant to their research areas and to read the literature critically and efficiently. Students analyze the components of research articles to pinpoint how knowledge claims are made and supported. (Occasionally)

EDE 557. Comprehensive Exam Research: Teaching and Curriculum PhD

(Fall, Spring, and Summer)

EDE 558. Comprehensive Exam Research: Teaching and Curriculum EdD

(Fall, Spring, and Summer)
**General/Foundations**

**ED 400. Topics in Teaching and Schooling, Part 1**

Prepares teachers to address the varied needs of their students and school, beyond typical curricular and academic responsibilities. Topics addressed include conflict resolution, educational law, ethics, listening and counseling skills, career preparation, and school and community relations. Also includes workshops on child abuse and violence prevention required by New York State. This is a two-semester course. Non-matriculated students are discouraged from taking this course; a select few by permission of instructor. (Fall, continues in Spring)

**ED 400A. Topics in Teaching and Schooling, Part 2**

Prerequisite: ED 400.

Prepares teachers to address the varied needs of their students and school, beyond typical curricular and academic responsibilities. Topics include conflict resolution, educational law, ethics, listening and counseling skills, career preparation, and school and community relations. Also includes workshops on child abuse and violence prevention required by New York State. This is a two-semester course. (Spring)

**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 consumerism on teaching and learning. (Fall, Spring, and Summer B)

**ED 409. Language and Literacy in Education**

Prerequisite: EDU 498 recommended.

Provides educators with an understanding of how language and literacy inform instruction and enhances students' learning in schools. Introduces students to the broad areas of language study 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. Provides an opportunity for reflecting upon the implications of language study for teaching and learning in schools in a global information economy. (Fall)

**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. (Fall and Summer A)

**EDU 442. Race, Class, Gender, and Disability in American Education**

Prepares educators to understand diversity issues, with the ultimate goal of eliminating existing practices of exclusion and inequality in schools and society. Surveys and critically analyzes literature on diversity and encourages students to examine their own positions of identity, including race and ethnicity, class, gender and sexual orientation, language, religious belief, age, and ability, and the consequences of these identity positions on teaching and learning in diverse settings. (Fall, Spring, and Summer B)

**EDU 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. (Fall and Summer A)

**EDU 464. Child Development and Learning in Context (Ages 5 to 12)**

Develops an understanding of what can be expected of children 5 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. (Summer A)

**EDU 498. Literacy Learning as Social Practice**

Develops an understanding of the social nature of language and literacy practices in and out of school. Examines theories of literacy learning and learning more generally, 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. Constructs an understanding of the social practice of literacy as the negotiation of the multiple linguistic and cultural realities of contemporary society across age levels and abilities. Open to students not matriculated in the teaching and curriculum program, with permission of instructor. (Fall and Summer A)
**Early Childhood Education**

**ED 407. Development, Learning, and Teaching for Children Ages Three to Five**

Provides an understanding of the developmental accomplishments, strengths, and limitations of children three to five and of the ways this development can be affected in positive or negative ways 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. Open to matriculated students only; preservice teachers take this course concurrently with student teaching in settings that serve preschool-aged children (e.g., EDF 442 or 443). (Spring)

**ED 408. Development, Learning, and Teaching for Children Ages Birth to Three**

Provides an understanding of the development that ordinarily occurs in children birth to three years old and of the ways this development can be affected in positive or negative ways by a variety of factors, including individual and environmental variables and instruction. Examines the range of programs designed to serve infants, the regulations that govern these programs, and the assessment tools commonly used with infants in medical and intervention settings. Preservice teachers take this course concurrently with field experiences in a setting that serves children ages birth to three (e.g., EDF 440 or 441). (Summer B, odd years)

**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. (Spring)

**EDU 477. Integrating Curriculum in Early Childhood**

Prepares early childhood and elementary teachers to create meaningful learning experiences for their students by integrating various subject matters. Examines existing integrated curricula for early childhood, in light of the cognitive, linguistic, and social development and instructional goals for preschoolers and students in grades K–2. Students also learn to create integrated learning experiences that support the development of the cognitive foundations essential to learning in elementary school, including language and literacy skills, attention regulation, problem solving, and a rich, coherent knowledge base. (Summer A, odd years)

**Elementary Education**

**EDU 427. Theory and Practice in Teaching and Learning Literacy in Elementary School**

Prerequisite: EDU 498.

Develops practices that support students’ literacy learning and in planning and implementing meaningful English language arts lessons in elementary classrooms, based on current understandings of literacy learning. Examines the construction of literacy and the effectiveness of progressive practices in the areas of curriculum development, instructional planning, and instructional strategies as specific to the elementary grades. Introduces and examines strategies to differentiate instruction so as to meet the needs of diverse students with a range of learning styles and abilities. Preservice teachers must take this course concurrently with their field experiences and fall student teaching (e.g., EDF 404 or 405; 406 or 407). (Fall)

**EDU 428. Theory and Practice in Teaching and Learning Social Studies in Elementary School**

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. Preservice teachers must take this course concurrently with their spring student teaching experience (e.g., EDF 408 or 409). (Spring)

**EDU 429. Theory and Practice in Teaching and Learning Science in Elementary School**

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 learning styles and abilities. Preservice teachers should take this course concurrently with their spring student teaching experience (e.g., EDF 408 or 409). (Spring)

**EDU 430. Theory and Practice in Teaching and Learning Mathematics in Elementary School**

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. Preservice
teachers should take this course concurrently with the 100-hour
field experience (e.g., EDF 404 or 405 or 410 or 411). (Fall)

EDU 440. Children's Literature and Literacy Learning
Prerequisite: 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 literary 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 de-
dsigned 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. (Summer B)

EDU 480A. Theory and Practice of Teaching and Learning the
Arts in Elementary School (Part 1)
Credit—one hour

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 technol-
ogy. 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. (Summer A)

EDU 480B. Theory and Practice of Teaching and Learning the
Arts in Elementary School (Part 2)
Credit—one hour

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 technol-
ogy. This is the second section of a two-part course; EDU 480B builds on assignments completed in EDU 480A. It is a field-
based project to be completed over the following fall semester af-
after completing EDU 480A during the previous summer A. (Fall)

English Education
EDU 431. Theory and Practice in Teaching and Learning English
Prerequisite: EDU 498 recommended.

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 lin-
guistically diverse learners. They question what should be taught,
why, and how in the secondary English language arts curriculum,
in light of relevant research on the learning and teaching of
English language arts, state and national standards, and promis-
ing practices. Topics addressed include multicultural literature,
integrating reading and writing instruction, teaching writing as a
process, teaching grammar in context, and authentic assessment
of language and literacy skills. Preservice teachers must take this
course concurrently with the 100-hour field experience. (Fall)

EDU 443. Implementing Innovation in English Education
Prerequisite: EDU 431 or permission of instructor.

Supports teachers in putting into practice what they learned in
EDU 431 to enhance their understanding of key issues in the
teaching and learning of the English language arts. Introduces
and critically examines innovative teaching methods, curricula,
and resources to support the teaching of the English language
arts, 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. Preservice 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.
(Spring)

EDU 481. Integrating English and Technology

Prepares secondary English teachers to effectively use technology
to enhance English language arts instruction, while furthering
their understanding of fundamental ideas and concepts in Eng-
lishe language arts. Examines educational technology as a teach-
ing and learning tool in English language arts and how technol-
ogy may affect instructional goals and teaching practices in
English education. Introduces and critically examines software,
equipment, and other technological resources that can support
the teaching of English language arts. (Summer B, odd years)

ESOL/Foreign Language Education
EDU 435. Theory and Practice in Teaching and Learning Foreign
Languages and ESOL (English to Speakers of Other Languages)
Prerequisite: EDU 480 or permission of instructor.

Introduces teachers to key issues in the teaching and learning of
a second language (foreign language or ESOL) in grades K–12.
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.
Preservice teachers must take this course concurrently with the
100-hour field experience. (Fall)

EDU 463. Implementing Innovation in Foreign Languages and
ESOL Education
Prerequisite: EDU 435 or permission of instructor.

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. Preservice 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. (Spring)

**ED 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. (Summer B)

**Mathematics Education**

**EDU 436. Theory and Practice in Teaching and Learning Mathematics**

Prepares teachers to make the learning of mathematics more meaningful and accessible to all students in secondary school. Examines the key questions of what mathematics should be taught, why, and how 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 grades 7–12. Introduces and examines strategies to differentiate instruction so as to meet the needs of diverse students with a range of learning styles and abilities. Preservice teachers must take this course concurrently with the 100-hour field experience. (Fall)

**EDU 444. Implementing Innovation in Mathematics Education**

Prerequisite: EDU 436 or permission of instructor.

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. Preservice 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. (Spring)

**EDU 482. Integrating Mathematics and Literacy**

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. (Summer B, even years)

**EDU 483. Integrating Mathematics and Technology**

Prepares secondary mathematics teachers to effectively use technology to enhance mathematics instruction, while furthering their understanding of fundamental ideas and concepts in mathematics. Examines educational technology as a teaching and learning tool in mathematics instruction and how technology may affect instructional goals and teaching practices in mathematics education. Introduces and critically examines software, equipment, and other technological resources that can support the teaching of various mathematical topics. (Summer B, odd years)

**EDU 489. Implementing Curriculum Reform in Mathematics**

Prerequisites: EDU 430, 436, and permission of instructor.

Prepares mathematics teachers interested in implementing the National Council of Teachers of Mathematics (NCTM) standards to use one of the exemplary comprehensive mathematics curricula developed for elementary, middle, and high school levels. Involves the in-depth analysis of one or more of the existing exemplary math curricula and the research available on their effectiveness; the implementation, documentation, and evaluation of at least one unit from one of these curricula; and the examination of what it takes to change an entire mathematics program to significantly improve the mathematical experience of all students in a school system. Instructor’s permission required (as candidates need access to an instructional context where they can complete the projects assigned in this course). (Occasionally)

**Reading and Literacies**

**EDU 495. Theory and Practice for Reading Professionals**

Prerequisites: Course must be taken concurrently with EDF 422 and EDU 498.

Prepares reading and literacies 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 are 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 inescapability of theory and practice in literacy education. For Reading and Literacies students or by permission of instructor. (Spring)
**ED 582. Critical Literacy**  
*Prerequisite: EDU 498 or permission of instructor.*  
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; and the role of literacy in production of power.  
*(Occasionally)*

**Science Education**  
**EDE 433. Teaching and Learning Science Outside of School**  
*Restriction: permission of instructor.*  
Part 1 of a 2-part course: This course is designed to offer the learning opportunities to further knowledge and understanding of scientific discourses, the nature of science, and pedagogical decision making for teaching science to minority females. Explores the research and theory that addresses issues of teaching science to females in an informal, urban setting. The primary goal of this course is to provide the student with support in developing an understanding of the nature of science and active unlearning of the formal discourse of science and in turn, feeling comfortable constructing safe, hybrid spaces for young females to discuss what science is, how science is done, who does science, etc. This course takes place concurrently with the after-school club, Science STARS (Students Tackling Authentic and Relevant Science) and therefore provides opportunities to turn the theory the student reads and discusses in class into practice in the field. As active agents of change, one goal of Science STARS is for these young women to develop critical consciousness, or the capacity to recognize and overcome sociopolitical barriers and further liberate themselves from these barriers by transforming their surroundings, rejecting passivity, and dialoguing strategies for a more equitable society. As near-peer mentors, supporting these young women in these journeys, the student must also become critically conscious and reject passivity.

**EDU 434. Theory and Practice in Teaching and Learning Science**  
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 instruction so as to meet the needs of diverse students with a range of learning styles and abilities. Preservice teachers must take this course concurrently with the 100-hour field experience.  
*(Fall)*

**EDU 448. Implementing Innovation in Science Education**  
*Prerequisite: EDU 434 or permission of instructor.*  
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. Preservice 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.  
*(Spring)*

**ED 474A. Implementing Reform-based Science Education A**  
*Prerequisite: permission of instructor.*  
This course is designed to engage participants in collectively articulating and implementing a socially just vision for science education. Students and instructor 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 and C are offered in the following fall and spring.  
*(Summer, occasionally)*

**ED 474B. Implementing Reform-based Science Education B**  
*Prerequisites: ED 474A and permission of instructor.*  
This course is designed to engage participants in collectively articulating and implementing a socially just vision for science education. Students and instructor 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 and C are offered in the preceding summer and following spring, respectively.  
*(Fall, occasionally)*

**ED 474C. Implementing Reform-based Science Education C**  
*Prerequisites: ED 474A and 474B and permission of instructor.*  
This course is designed to engage participants in collectively articulating and implementing a socially just vision for science education. Students and instructor 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 and B are offered in the preceding summer and fall, respectively.  
*(Spring, occasionally)*

**EDU 486. Integrating Science and Technology**  
*Prerequisite: EDU 487 or permission of instructor.*  
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. (Summer B)

**EDU 487. 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. (Summer A, odd years)

**Social Studies Education**

**EDU 432. Theory and Practice in Teaching and Learning Social Studies**  
*Prerequisite: EDU 442 recommended.*
Prepares teachers as reflective practitioners of social studies education who make the interdisciplinary study of history, geography, and the social sciences meaningful, exciting, and accessible to all students in secondary schools. Explores historical and contemporary issues related to the social studies while promoting critical dialogue about key questions of what should be taught, why, and how in light of relevant theory, research, and national and state standards. Supports students in planning, implementing, and reflecting on instructional units. The emphasis throughout this course is on preparing teachers to build democratic communities of learners who practice the skills of participatory citizenship by learning to think constructively, conceptually, and critically about social studies. Preservice teachers must take this course concurrently with the 100-hour field experience. (Fall)

**EDU 433. Integrating Social Studies and Literacy**
Prepares social studies teachers to effectively use literacy theory and practices to facilitate the development of the skills their students need to become active citizens in a global society who recognize and act on issues of equity and social justice. Enhances teachers’ understanding of the fundamental interdisciplinary themes and concepts in social studies, particularly those related to historical and contemporary global connections and cultural diversity. (Summer, odd years)

**EDU 462. Implementing Innovation in Social Studies Education**  
*Prerequisite: EDU 432 or permission of instructor.*
Supports teachers in the integration of theory, research, and practice in social studies education. With an emphasis on education for citizenship in a culturally pluralistic democracy, teachers examine and experience innovative teaching methods, curricula, resources, and authentic performance assessment strategies that support social studies learning consistent with state and national standards. Introduces and examines strategies designed to meet the needs of diverse students with a range of learning styles and abilities. Introduces teachers to reflective action research strategies that support their continued professional development. Preservice 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 the course. (Spring)

**EDU 499. Integrating Social Studies and Technology**
Prepares secondary social studies teachers to effectively use technology to enhance social studies learning, while furthering their understanding of interdisciplinary themes and concepts in social studies, in particular those connecting science, technology, and society. Examines information and communication technology (ICT) as a teaching and learning tool in social studies and as an avenue for cross-cultural and international communication and cooperation. Through content-specific immersion in the culture of technology, introduces skills needed to critically and reflectively infuse electronic technology into educational programs in authentic and culturally relevant ways that empower learners as active citizens of a global society. Examines the complex, dynamic, and reciprocal relationship between information and telecommunication technology and society. (Summer, even years)

**Inclusion**

**ED 403. Disability and Early Childhood**
Develops an understanding of disability, especially as it impacts young children. Addresses the inclusion debate, as well as the diagnosis, classification, and assessment of young children with disabilities. Examines the historical context for early intervention and special education and the institutional approach to disabilities and utilizes that context to critically examine and discuss current intervention and educational practices for young children with diverse developmental paths and learning abilities. Introduces some strategies for working with young children with disabilities in various contexts and for developing collaborative partnerships and teams to best meet the full range of needs of young children with disabilities. (Summer A, even years)

**ED 405. Assessment in Instructional Contexts**
Provides an understanding of assessment as a tool to inform instruction in general, and inclusive education in particular, across age levels. Examines the multiple contexts in which assessment is meaningful. Provides a critical analysis of the tradition of student testing and its consequences on teaching and learning across content areas, age levels, and abilities. (Fall and Summer B)

**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 develop for teachers a personal model of collaboration and team building with colleagues, parents, and students. (Spring and Summer B)
ED 451. Teaching and Learning in Inclusive Classrooms
Prerequisite: ED 447 (or ED 403 for early childhood students) or permission of instructor.

Assists teachers by providing critical understanding and skills to meet the needs of all students in inclusive classrooms. Provides an opportunity for students 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. (Summer B)

ED 452A. Instructional Strategies for Inclusive Classrooms A
Prerequisites: ED 447 and 451 or permission of instructor.

Building on what was 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. (Fall)

ED 452B. Instructional Strategies for Inclusive Classrooms B
Prerequisite: ED 452A or permission of instructor.

Building on what was 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. (Spring)

ED 452C. Instructional Strategies for Inclusive Classrooms C
Prerequisites: ED 452A and 452B or permission of instructor.

Building on what was 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. (Summer A)

EDU 475. Early Interventions for Children with Disabilities
(Ages Three to Five)

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, or suspected of having, 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. (Spring, even years)

EDU 476. Early Intervention for Children with Disabilities (Ages Birth to Three)

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 with young children with, or suspected of having, 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. (Summer B, odd years)

Doctoral Studies

EDU 525. Theory and Research in Teaching and Learning

Provides doctoral students with a solid grounding in the research literature on the processes of teaching and learning as a basis for more advanced and specialized studies in these and other related areas. Doctoral students only. (Fall)

EDU 526. Theory and Research in Curriculum and Change

Provides doctoral students with a solid grounding in the research literature on curriculum and reform in education as a basis for more advanced and specialized studies in these and other related areas. Doctoral students only. (Spring)

EDU 527. Advanced Doctoral Seminar in Teaching and Learning
Prerequisite: EDU 525 (unless waived by instructor for students outside of teaching and curriculum).

With each offering, this course focuses on a different topic within the areas of teaching and learning, examining issues and results from the relevant literature. The goal of this course is to enable doctoral students with an interest in the processes of teaching and learning to deepen their understanding of these areas as they prepare for doing independent research. Doctoral students only or permission of instructor. (Spring)
EDU 528. Advanced Doctoral Seminar in Curriculum and Pedagogy
Prerequisite: EDU 526 (unless waived by instructor for students outside of teaching and curriculum).

With each offering, this course focuses on a different topic within the areas of curriculum and pedagogy, examining issues and results from the relevant literature. The goal of this course is to enable doctoral students with an interest in issues related to curriculum and pedagogy to deepen their understanding of these areas as they prepare for doing independent research. Gender and Sexual Justice in American Education—gender and sexual differences have played crucial roles in determining the content of, access to, participation in, and aims of K–12 education in the United States. This course explores how gender and sexuality have mediated discourses on social justice in American K–12 educational contexts since the early twentieth century. Feminist, womanist, masculinity, and queer theories provide conceptual lenses for our examinations of K–12 schools as sites of social reproduction and resistance. Additionally, connections when possible to local educational spaces and practitioners provide opportunities to consider the aims and impact of contemporary discourses on gender and sexuality in academic settings. As an advanced doctoral seminar, this course requires thorough readings of assigned texts and thoughtful participation in class discussions. This course also requires response papers, student-led facilitations of class activities, and a final project that addresses gender and/or sexual justice in American education. Students who enroll in this course should have some prior exposure to critical theories on gender and sexual difference, as well as a genuine interest in social justice issues in education. Doctoral students only or permission of instructor. (Fall)

ED 551A. Teaching and Curriculum Doctoral Cohort Seminar 1A
Cohort groups for the Accelerated EdD program meet monthly with a faculty member over the first two years to discuss coursework, research topics, and support one another through the portfolio and comprehensive exam processes. For accelerated EdD students only who have completed the comprehensive exam. (Summer)

ED 551B. Teaching and Curriculum Doctoral Cohort Seminar 1B
Cohort groups for the Accelerated EdD program meet monthly with a faculty member over the first two years to discuss coursework, research topics, and support one another through the portfolio and comprehensive exam processes. For accelerated EdD students only who have completed the comprehensive exam. (Fall)

ED 551C. Teaching and Curriculum Doctoral Cohort Seminar 1C
Cohort groups for the Accelerated EdD program meet monthly with a faculty member over the first two years to discuss coursework, research topics, and support one another through the portfolio and comprehensive exam processes. For accelerated EdD students only who have completed the comprehensive exam. (Spring)

ED 552A. Teaching and Curriculum Doctoral Cohort Seminar 2A
Cohort groups for the Accelerated EdD program meet monthly with a faculty member over the first two years to discuss coursework, research topics, and support one another through the portfolio and comprehensive exam processes. For accelerated EdD students only who have completed the comprehensive exam. (Summer)

ED 552B. Teaching and Curriculum Doctoral Cohort Seminar 2B
Cohort groups for the Accelerated EdD program meet monthly with a faculty member over the first two years to discuss coursework, research topics, and support one another through the portfolio and comprehensive exam processes. For accelerated EdD students only who have completed the comprehensive exam. (Fall)

ED 552C. Teaching and Curriculum Doctoral Cohort Seminar 2C
Cohort groups for the Accelerated EdD program meet monthly with a faculty member over the first two years to discuss coursework, research topics, and support one another through the portfolio and comprehensive exam processes. For accelerated EdD students only who have completed the comprehensive exam. (Spring)

ED 553. Teaching and Curriculum Dissertation Proposal Seminar
Provides students in the Accelerated EdD 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. For accelerated EdD students only. (Varies, in sequence)

ED 554. Action Research Dissertation Seminar I
Prerequisite: ED 553.
Provides a supported research experience for students in the accelerated EdD 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. For accelerated EdD students only. (Fall)

ED 555. Action Research Dissertation Seminar II
Prerequisite: ED 554.
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. For accelerated EdD students only. (Spring)

ED 588. Doctoral Seminar: Topics in Teaching and Curriculum
This doctoral seminar focuses on a different topic in research each time it is offered. Doctoral students only. (Spring)
**Health Professions Education**

**EDU 497. Teaching and Learning in Higher Education**
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. (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. (Fall)

**EDU 581. Clinical Teaching in Health Care Professions Education: Teaching and Instructional Methods**
*Prerequisites: EDU 497 required; 580 recommended.*

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. (Spring)

The following courses are teaching internships (at different grade levels and in different settings), which also include a one-hour weekly seminar concurrent with the individual experiences taking place in the field.

Open to candidates matriculated in a teaching preparation program; University of Rochester undergraduates and other students with permission of instructor.

*Prerequisite: these internships should be taken concurrently with the corresponding methods courses.*

**EDF 404. Field Experiences in Elementary Schools**
*Credit—two hours*  
(Fall)

**EDF 405. Field Experiences in Inclusive Elementary School Settings**
*Credit—two hours*  
(Fall)

**EDF 406. Student Teaching in Elementary Schools A**
*Credit—three hours*  
(Fall)

**EDF 407. Student Teaching in Inclusive Elementary School Settings A**
*Credit—three hours*  
(Fall)

**EDF 408. Student Teaching in Elementary Schools B**
*Credit—four hours*  
(Spring)

**EDF 409. Student Teaching in Inclusive Elementary School Settings B**
*Credit—four hours*  
(Spring)

**EDF 416E. Field Experiences in Secondary Schools (English)**
*Credit—two hours*  
(Fall)

**EDF 416F. Field Experiences in Secondary Schools (Foreign Languages + Latin)**
*Credit—two hours*  
(Fall)

**EDF 4416H. Field Experiences in Secondary Schools (Social Studies)**
*Credit—two hours*  
(Fall)

**EDF 416M. Field Experiences in Secondary Schools (Math)**
*Credit—two hours*  
(Fall)

**EDF 416S. Field Experiences in Secondary Schools (Science)**
*Credit—two hours*  
(Fall)

**EDF 417D. Field Experiences in Inclusive Secondary School Settings (generalist)**
*Credit—two hours*  
(Fall)

**EDF 417E. Field Experiences in Inclusive Secondary School Settings (English)**
*Credit—two hours*  
(Fall)
EDF 417F. Field Experiences in Inclusive Secondary School Settings (Foreign Languages + Latin)  
Credit—two hours  
(Fall)

EDF 417H. Field Experiences in Inclusive Secondary School Settings (Social Studies)  
Credit—two hours  
(Fall)

EDF 417M. Field Experiences in Inclusive Secondary School Settings (Math)  
Credit—two hours  
(Fall)

EDF 417S. Field Experiences in Inclusive Secondary School Settings (Science)  
Credit—two hours  
(Fall)

EDF 418E. Student Teaching in Secondary Schools A (English)  
Credit—three hours  
(Spring)

EDF 418F. Student Teaching in Secondary Schools A (Foreign Languages + Latin)  
Credit—three hours  
(Spring)

EDF 418H. Student Teaching in Secondary Schools A (Social Studies)  
Credit—three hours  
(Spring)

EDF 418M. Student Teaching in Secondary Schools A (Math)  
Credit—three hours  
(Spring)

EDF 418S. Student Teaching in Secondary Schools A (Science)  
Credit—three hours  
(Spring)

EDF 419D. Student Teaching in Inclusive Secondary School Settings A (generalist)  
Credit—three hours  
(Spring)

EDF 419E. Student Teaching in Inclusive Secondary School Settings A (English)  
Credit—three hours  
(Spring)

EDF 419F. Student Teaching in Inclusive Secondary School Settings A (Foreign Languages and Latin)  
Credit—three hours  
(Spring)

EDF 419H. Student Teaching in Inclusive Secondary School Settings A (Social Studies)  
Credit—three hours  
(Spring)

EDF 419M. Student Teaching in Inclusive Secondary School Settings A (Math)  
Credit—three hours  
(Spring)

EDF 419S. Student Teaching in Inclusive Secondary School Settings A (Science)  
Credit—three hours  
(Spring)

EDF 420E. Student Teaching in Secondary Schools B (English)  
Credit—four hours  
(Spring)

EDF 420F. Student Teaching in Secondary Schools B (Foreign Languages and Latin)  
Credit—four hours  
(Spring)

EDF 420H. Student Teaching in Secondary Schools B (Social Studies)  
Credit—four hours  
(Spring)

EDF 420M. Student Teaching in Secondary Schools B (Math)  
Credit—four hours  
(Spring)

EDF 420S. Student Teaching in Secondary Schools B (Science)  
Credit—four hours  
(Spring)

EDF 421D. Student Teaching in Inclusive Secondary School Settings B (generalist)  
Credit—four hours  
(Spring)

EDF 421E. Student Teaching in Inclusive Secondary School Settings B (English)  
Credit—four hours  
(Spring)
EDF 421F. Student Teaching in Inclusive Secondary School Settings B (Foreign Languages and Latin)  
Credit—four hours  
(Spring)

EDF 421H. Student Teaching in Inclusive Secondary School Settings B (Social Studies)  
Credit—four hours  
(Spring)

EDF 421M. Student Teaching in Inclusive Secondary School Settings B (Math)  
Credit—four hours  
(Spring)

EDF 421S. Student Teaching in Inclusive Secondary School Settings B (Science)  
Credit—four hours  
(Spring)

EDF 422. Practica in Teaching Literacy  
Credit—three hours  
(Spring)

EDF 423. Practica in Teaching Literacy in Elementary Schools  
Credit—three hours  
(Fall)

EDF 424. Practica in Teaching Literacy in Middle Childhood  
Credit—three hours  
(Fall)

EDF 425. Practica in Teaching Literacy in Secondary Schools  
Credit—three hours  
(Spring)

EDF 426. Field Experiences in ESOL  
Credit—two hours  
(Fall)

EDF 428. Student Teaching in ESOL in Elementary Schools  
Credit—three hours  
(Spring)

EDF 430. Student Teaching in ESOL in Secondary Schools  
Credit—four hours  
(Spring)

EDF 432. Student Teaching in ESOL  
Credit—three hours  
(Spring)

EDF 440. Field Experiences with Children 0–3  
Credit—two hours  
(Summer B, odd years)

EDF 441. Field Experiences with Children 0–3 in Inclusive Settings  
Credit—two hours  
(Summer B, odd years)

EDF 442. Student Teaching with Preschool Children  
Credit—two hours  
(Spring)

EDF 443. Student Teaching with Preschool Children in Inclusive Settings  
Credit—two hours  
(Spring)

Open to candidates matriculated in a teaching preparation program; University of Rochester undergraduates and other students with permission of instructor.
Inventory of Registered Programs

The New York State Education Department has authorized the University of Rochester to offer the graduate-level programs that appear in the following inventory.

### School of Arts & Sciences

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### Eastman School of Music

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<td>0808</td>
<td>Inclusion Adolescence Education: Chemistry</td>
<td>MS-B</td>
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### Teaching—English (initial certification)

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<th>Program Name</th>
<th>Degree</th>
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<tbody>
<tr>
<td>25016</td>
<td>0804.10</td>
<td>Middle Childhood Education: Foreign Languages</td>
<td>MS-B</td>
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<tr>
<td>25044</td>
<td>1103</td>
<td>Adolescent Education: Foreign Languages (German, Italian, or Chinese)</td>
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<td>25054</td>
<td>1103.01</td>
<td>Adolescent Education: German</td>
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<td>25078</td>
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<td>Inclusive Adolescence Education: German</td>
<td>MS-B</td>
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### Teaching—French (initial certification)

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<tbody>
<tr>
<td>34424</td>
<td>0808</td>
<td>Teaching Students with Disabilities in Secondary School as Generalist</td>
<td>MS-B</td>
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</table>
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<table>
<thead>
<tr>
<th>Program Code</th>
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<th>Degree</th>
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<tbody>
<tr>
<td>34425</td>
<td>0808</td>
<td>Teaching Students with Significant Disabilities</td>
<td>MS</td>
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### Teaching — professional certification for current teachers

<table>
<thead>
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<tbody>
<tr>
<td>25031</td>
<td>0829</td>
<td>Professional Study: Generalist</td>
<td>MS-C</td>
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<td>25030</td>
<td>0804</td>
<td>Middle Childhood Education for Adolescence Education Teachers</td>
<td>MS-C</td>
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<tr>
<td>25033</td>
<td>0829</td>
<td>Professional Studies in Adolescence Education</td>
<td>MAT-C</td>
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<tr>
<td>25032</td>
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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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<tr>
<td>36980</td>
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<td>Online Teaching and Learning</td>
<td>MS</td>
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### Advanced Certification Programs

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<tbody>
<tr>
<td>10648</td>
<td>0826.01</td>
<td>Counseling &amp; Human Development</td>
<td>Adv. Cert-C</td>
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<tr>
<td>25014</td>
<td>0823</td>
<td>Early Childhood Education</td>
<td>Adv. Cert-B</td>
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<td>25040</td>
<td>0823</td>
<td>Inclusion Early Childhood Education</td>
<td>Adv. Cert-B</td>
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<tr>
<td>25035</td>
<td>0802</td>
<td>Childhood Education</td>
<td>Adv. Cert-B</td>
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<tr>
<td>25041</td>
<td>0802</td>
<td>Inclusion Childhood Education</td>
<td>Adv. Cert-B</td>
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<td>25017</td>
<td>1508</td>
<td>Teaching English to Speakers of Other Languages</td>
<td>Adv. Cert-B</td>
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<tr>
<td>25019</td>
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<td>Teaching Literacy</td>
<td>Adv. Cert-B</td>
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<tr>
<td>25025</td>
<td>0804</td>
<td>Middle Childhood Specialist</td>
<td>Adv. Cert-B</td>
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<tr>
<td>25027</td>
<td>0803</td>
<td>Adolescence Education</td>
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<td>0808</td>
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<td>Adv. Cert-B</td>
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<td>28986</td>
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<td>School Building Leadership</td>
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<td>28988</td>
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<td>School District Leadership</td>
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<td>34426</td>
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### Joint Degree Programs

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<tbody>
<tr>
<td>22196</td>
<td>0506</td>
<td>Business Administration</td>
<td>MBA</td>
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</table>

A=Initial teaching certification  
B=Initial and professional teaching certification  
C=Professional teaching certification
Senior University Administration

Joel Seligman
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Dean of the William E. Simon School of Business

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The Mary W. and Donald R. Clark Director of the Memorial Art Gallery

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Deputy to the President

Richard Waugh
Associate Vice President for Research and New Initiatives

David R. Williams
Dean of Research, Arts, Sciences & Engineering and William G. Allyn Professor of Medical Optics

Current as of January 7, 2015
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, William E. Simon Graduate School of Business Administration, 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.
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