Northwestern

The Graduate School Catalog
2019–20
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THE GRADUATE SCHOOL

The Graduate School enhances Northwestern University's academic excellence and reputation by providing centralized support to current and prospective graduate students, postdoctoral trainees, graduate faculty, staff, administrators, and alumni. We promote a transformative educational experience for all graduate students and postdoctoral trainees at Northwestern University.

Our mission is to create and communicate an intentional and adaptable educational infrastructure for a diverse population of graduate students and postdoctoral trainees in an accessible and equitable environment. We advocate for excellent graduate and advanced educational opportunities; cultivate a healthy, diverse, and engaged community; and connect graduate students and postdoctoral trainees with supportive communities and global opportunities.

For more information on our academic programs and services, visit The Graduate School website (https://www.tgs.northwestern.edu).
ACADEMIC POLICIES AND PROCEDURES

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Academic Calendar

Academic deadlines are published in the University’s Academic Calendar (https://www.registrar.northwestern.edu/calendars).

Academic Integrity

Students in The Graduate School are expected to conduct their academic work, scholarship, research, teaching and other professional responsibilities with the highest standard of academic integrity. Academic misconduct is a serious matter for graduate students committed to scholarly pursuits. The Graduate School enforces Northwestern University’s common principles of academic integrity that are outlined on the Office of the Provost’s “Principles Regarding Academic Integrity” webpage (https://www.northwestern.edu/provost/policies/academic-integrity/principles.html) under “A. Basic Standards of Academic Integrity.” More detailed standards of academic conduct, procedures, and sanctions are set forth below.

Standards of Academic Integrity

Basic standards of academic integrity are outlined by the Office of the Provost (https://www.northwestern.edu/provost/policies/academic-integrity/principles.html). In addition to these basic standards, students in The Graduate School:

- must be aware of and comply with Northwestern University policies and procedures regarding responsible conduct of research (https://www.researchintegrity.northwestern.edu/research-misconduct)
- must adhere to standards of academic integrity in completion of academic milestones including, but not limited to, master’s thesis, PhD qualifying exams, PhD prospectus, PhD dissertation, and carrying out of other academic requirements and responsibilities

Academic Integrity Violations Procedures

The exact academic integrity violations procedures depend on whether the alleged violation occurred in a class and if so, which school oversees the class.

Reporting of Alleged Academic Misconduct

Any case of alleged academic misconduct involving a student in The Graduate School (TGS) must be reported by the complainant (course instructor, faculty member involved in graduate education, other party) to the appropriate Assistant or Associate Dean (https://www.northwestern.edu/provost/policies/academic-integrity/counseling-and-contacts.html). Allegations of dishonesty related to a class will be referred by the instructor to the appropriate Assistant or Associate Dean (https://www.northwestern.edu/provost/policies/academic-integrity/counseling-and-contacts.html) of the school that offers the course. If, for example, the course is offered in the McCormick School of Engineering, whether an undergraduate or graduate level course, the matter will be referred to the contact for the McCormick School of Engineering for investigation into the allegations and whether misconduct has occurred.

Allegations of academic misconduct not related to a class (including, but not limited to, qualifying exams, prospectus, master’s thesis, dissertation) or related to classes overseen by The Graduate School will be adjudicated by the Associate Dean for Graduate Student and Postdoctoral Affairs in The Graduate School (TGS-ADSA@northwestern.edu).

Reports of academic misconduct must be made in writing no later than thirty days from the date of the alleged incident, or within thirty days of the complainant becoming aware of the alleged misconduct. Once a matter has been referred to the Associate Dean, it may not be withdrawn without approval, nor may the complainant resolve the case independently.

Students charged with academic misconduct may not change their registration in a class in which a charge is pending, or in which a finding of academic misconduct has been made.

Case Review

The appropriate school contact (https://www.northwestern.edu/provost/policies/academic-integrity/counseling-and-contacts.html) will review the case of alleged academic misconduct according to their documented process. This may include reviewing statements from the complainant, statements and/or supporting materials from the instructor or Director of Graduate Studies (DGS), and any other supporting materials. If it is determined that there are sufficient grounds to warrant further action, the student will be notified in writing.

Notice of Alleged Academic Misconduct

Once it has been determined through the case review that there are sufficient grounds for further action, the student will be notified of the allegation and the next steps. The exact process depends on which school is responsible for the investigation (https://www.northwestern.edu/provost/policies/academic-integrity).

When alleged academic misconduct is investigated by The Graduate School, the Associate Dean for Graduate Student and Postdoctoral Affairs will notify the student/former student in writing by email. The notification will indicate:
• the charges made
• the date of the incident (if known)
• the individual(s) reporting the charges
• the nature of the alleged violation

The student will have ten business days from the date of this notification to request a meeting with the Associate Dean for Graduate Student and Postdoctoral Affairs to discuss the case and present any relevant materials or statements. If the student fails to schedule a meeting within ten business days or does not wish to meet, the Associate Dean may make a determination on the basis of the available evidence. The Associate Dean may grant reasonable requests for an extension of this time deadline at their sole discretion. Prior to this meeting, the student will be allowed to view the case materials and respond in writing.

Meeting with the Academic Integrity Contact
Student(s) charged with academic misconduct will participate in a meeting during which the student involved may be heard and the accuracy of the charge determined by a neutral decision-maker.

The individual responsible for investigating academic misconduct allegations has the authority to determine, based on a preponderance of the evidence available, whether a violation of academic integrity has occurred.

Sanctions
All proven cases of academic dishonesty will be penalized as appropriate under the circumstances. Sanctions other than a reduced or failing grade will be imposed by the school in which the student is enrolled. The imposition of any sanction other than a private reprimand will include a statement of reasons supporting its severity. Sanctions may include but are not limited to:

• Reduced or failing grade.
• A letter of reprimand and warning.
• A defined period of suspension, up to one year. Ineligibility for certain awards, honors and special programs.
• Revocation of an awarded degree.
• Permanent exclusion from the University (noted on official transcript).
• Any appropriate combination of the above.

It should be understood that there is no necessary connection between a first-time offense and a letter of reprimand. Depending on the nature of the offense, a student may be suspended or permanently excluded as a result of a first-time offense. Any grade entered for a student in a course in which an allegation of violations of academic integrity is pending against the student, whether for the course as a whole or for a piece of work submitted in the course, is subject to modification after all proceedings and appeals are concluded. Should the student be found to have violated academic integrity, the course instructor is empowered, in their sole discretion, to determine the effect this violation will have on the student’s grade in the course. Possible actions range from disregarding the incident in calculating the grade to failing the student in the course.

When a student in The Graduate School is alleged to have violated academic integrity in a course outside of The Graduate School, the authority of that school will extend only to determining whether or not the alleged action constitutes a violation of academic integrity and, if so, to the imposition of a grade penalty by the instructor in the course. If the finding is affirmative and all appeals have been exhausted or the time for appeals has expired, the case will be formally referred to the Associate Dean for Graduate Student and Postdoctoral Affairs for whatever further sanction The Graduate School deems appropriate.

Academic integrity findings and sanctions by The Graduate School do not preclude a student’s academic program from taking additional actions that it may deem warranted based on such findings.

The student will be notified by letter of the outcome of the investigation and the resulting sanction, if any.

Appeals
The student may appeal any adverse initial determination in writing within ten business days of the date of the initial decision letter. The written notice of appeal must state what is being appealed (whether the finding that a violation occurred, the sanction imposed, or both) and must describe in detail the grounds for the appeal. The appeal should specifically outline what parts of the written record are incorrect or reasons why the findings or sanction(s) are inappropriate.

If appealing the finding, the student must follow the appeal process of the school that determined there was a violation of academic integrity. If appealing the sanction, the student must follow the appeal process of the school that applied the sanction.

Appeals to The Graduate School will be reviewed by an ad hoc faculty committee with whom the student may meet, in person, if requested. The intent of The Graduate School’s appeals process may be to reassess whether academic misconduct occurred and/or whether the sanction was commensurate with the finding. Generally, implementation of sanctions will be suspended until all appeals made by the student have been exhausted. If no appeal is filed within ten business days of the initial notification, the decision shall become final and will be implemented at the conclusion of the appeal period.

Following its review and meeting, The Graduate School’s appeal committee may sustain or reverse the finding of the Associate Dean for Graduate Student and Postdoctoral Affairs and may, if finding of a violation stands, sustain or modify the sanction(s). The student will be informed of the committee’s decision in writing.

Appeals to the Provost
The student may appeal the decision of the appeal committee to the Provost of the University. An appeal to the Provost must be submitted within ten business days from the date of the appeal committee’s written notification to the student. Such appeals must be in writing and include a detailed statement setting forth the grounds for the appeal. Appeals to the Provost will be limited to alleged errors in procedures, interpretation of regulations, or alleged manifest discrepancies between the evidence and a finding and/or sanction. The Provost’s decision is final.

Reportability
Sanctions that do not result in separation from the University (suspension or exclusion) are not reported by Northwestern University to external entities unless: 1) the student consents to the disclosure; or 2) disclosure is required by law.

Ad Hoc Combined Degrees
Students in The Graduate School are admitted to approved PhD programs and must follow a plan of study related to that academic program.

Doctoral students may propose to pursue a TGS master’s degree outside of their approved academic program. This allows doctoral students to
pursue a secondary (supplemental) master's program that is not a part of
their existing program of study.

Eligibility

• Doctoral students in The Graduate School may petition to pursue a
master’s degree outside of their approved academic program when:
  • the secondary master’s degree relates to the student’s area of
specialization and can enhance the student’s scholarship, and
  • it would be impossible for a student to fulfill academic/
intellectual goals solely through the program into which they were
initially admitted, or through an existing cluster or certificate.
• Students proposing to pursue a master’s degree outside of their
approved PhD program must be in good academic standing.
• The petition (http://www.tgs.northwestern.edu/documents/policies/
AdHocCombinedDegreeApplicationForm.pdf) requires permission
from the student’s Director of Graduate Studies, the student’s faculty
adviser, the Director of Graduate Studies for the master’s degree, and
The Graduate School, per the procedure outlined below.
  • Students petitioning for a master’s degree along the way to
a PhD within their approved academic program do not follow
the process below. Rather, they should follow the policies
and procedures outlined in their program’s handbook and The
Graduate School’s catalog. A student who plans to receive or has
already received a master’s degree along the way to a PhD
within an approved academic program may propose to pursue
an additional master’s degree outside of the approved academic
program by following the procedure outlined below.
  • In order to receive a master’s degree outside of the approved
academic program, students must satisfy The Graduate School’s
minimum requirements for each of the degrees without double-
counting courses or other requirements. For each degree • the PhD
degree and the master’s degree of the approved academic
program • the student must minimally complete nine, quality letter
graded (ABC, not P/NP) courses authorized by The Graduate School
for graduate credit.
    • Each program may, at its discretion, allow the double counting
of courses for work beyond The Graduate School’s minimum
requirements.
  • The master’s degree outside of the approved PhD program may not
be conferred before the PhD is conferred. A student who departs
(withdraws, is dismissed, or otherwise discontinued from) the PhD
program to which the student was originally admitted becomes
ineligible for the secondary master’s degree.
  • A limited number of introductory courses taken at Northwestern
prior to approval of the petition may be accepted to satisfy graduate
degree requirements. In no case will more than four units of
coursework taken prior to admission into the master’s degree
program be counted toward the master’s degree requirement.

Procedure for Requesting Permission to
Pursue an Ad Hoc Combined Degree

To request permission to pursue concurrent degrees outside of
an existing combined degree program, students must submit
the Permission to Pursue an Ad Hoc Combined Degree form
(https://www.tgs.northwestern.edu/documents/policies/
AdHocCombinedDegreeApplicationForm.pdf) to Student Services
(gradservices@northwestern.edu) that provides:
  • An explanation of the academic/intellectual rationale for the plan of
study
  • A written description of the student’s plan to fulfill all published
requirements for each degree without double counting The Graduate
School’s minimum requirements for courses and other work
  • A statement from the student’s faculty adviser(s) supporting the
rationale for pursuing a master’s degree outside of the approved
PhD program and confirming that the student is making acceptable
progress in the approved PhD program
  • Statements from the Directors of Graduate Studies (DGSes) in
both the student’s PhD program and the master’s degree program
confirming that the outlined plan of study is acceptable and that the
student has permission to pursue the degrees concurrently.

Certificate Requirements

The Graduate School at Northwestern University offers
approved Graduate Certificates (https://www.tgs.northwestern.edu/
academics/programs/clusters-and-certificates/how-to-apply.html) that
enable students to gain competencies in or across fields. Some Graduate
Certificates may be pursued in conjunction with a degree program
while others may be pursued independent of another degree. Graduate
Certificates are typically available to students currently enrolled in
The Graduate School in a PhD or master’s program. Certain Graduate
Certificates are available to students who are not pursuing a PhD or
master’s degree and require admission into a non-degree TGS program.
For a list of available certificates and links to specific certificate
requirements, visit the Cluster and Certificate section of The Graduate
School’s website (http://www.tgs.northwestern.edu).

Students currently enrolled in a PhD or master’s program in TGS and who
wish to pursue a Graduate Certificate may only do so when the Graduate
Certificate goes beyond the degree program requirements and is an
extension of the student’s expertise into a different field.

Coursework

• Students must complete at least five quality letter-graded (ABC, not
P/NP) courses authorized for Graduate School credit. Individual
Graduate Certificates may require additional courses or specific
course requirements. See the descriptions for additional information.
Students must have a minimum cumulative GPA of 3.0 for the
courses counting toward the Graduate Certificate.
  • The Graduate School allows students to count courses towards both
the Graduate Certificate and degree. Graduate Certificate programs
may have more strict requirements. PhD and master’s students
are encouraged to inquire with the Graduate Certificate Program
Director about which courses may count towards both the Graduate
certificate and degree requirements.
  • Students who wish to pursue multiple Graduate Certificates may not
count the same coursework for more than one certificate.

Certificate Awarding

• In order to petition to have a Graduate Certificate awarded and
appear on the transcript, students must submit the Application for a
Graduate Certificate (https://webso.it.northwestern.edu/amserver/
UI/Login?goto=https%3A%2F%2Fwww.forms.northwestern.edu
%2Fform_templates%2FfillFormSection%2F34) once all Graduate
Certificate requirements have been completed, but no later than
the time that the student files for graduation (in the final quarter of
study). Each course counting toward the Graduate Certificate must
be listed. The Application for Graduate Certificate requires approval by the Certificate Program Director and, for students also pursuing a PhD or master’s, the Director of Graduate Studies (DGS) of the degree program.

- In the event that a student pursuing a PhD or master’s degree wishes to depart the University prior to awarding of the PhD or master’s, but after having completed the requirements for the Graduate Certificate, a form must be completed informing The Graduate School of the change in credential.
- Graduate Certificates will be issued and noted on the student’s transcript.
- Questions should be directed to gradservices@northwestern.edu.

Change in Degree Sought

Any student admitted to The Graduate School who wishes to change the degree sought from non-degree to Master’s or PhD, or from Master’s to PhD should first consult their program of study. The student must then submit an online application (https://www.applyweb.com/nugrad) and be sure to accurately respond to the first page of questions. Programs may require supporting documents to consider the request. Up to four course units taken as a non-degree student may be accepted to satisfy graduate degree requirements if approved by TGS and the admitting program.

Students who wish to change the degree sought from PhD to Master’s should consult the policy on withdrawal (p. 23).

Diversity Statement

A diverse student population is a key element of the educational experience of students in The Graduate School (TGS). Diversity presents itself in many different forms such as: socioeconomic status, race or ethnicity, religion, gender, sexual orientation, nationality or place of origin, disability, unique work or life experience, etc. It is the goal of TGS to cultivate an environment that values diverse backgrounds, approaches, and perspectives—all essential ingredients for true academic excellence.

General Registration Policies

Only students who have been officially admitted and matriculated into The Graduate School may register for courses to earn credits toward a Graduate School degree. The Office of the Registrar maintains a complete, up-to-date online class schedule, which can be found by selecting the “View the Quarterly Class Schedule” link on CAESAR (https://caesar.northwestern.edu). A quarterly reference copy is also available.

Full Time Study

Full-time study is defined as no fewer than three and no more than four course units of credit per quarter. Most courses carry one unit of credit.

Part Time Study

PhD students who, in exceptional cases, have received written approval of the program and Dean of The Graduate School to study on a part-time basis must meet the continuous registration requirement as well as all degree requirements, including coursework and milestones.

Master’s students who have the program’s approval to study on a part-time basis may meet the minimum coursework requirement by registering in one or two course units per quarter.

Registering

All students register online through CAESAR (https://caesar.northwestern.edu) by the published registration deadlines. Registration deadlines are listed on the University Academic Calendar (https://www.registrar.northwestern.edu/calendars). For courses requiring program consent, students should contact the department offering the course to obtain permission numbers.

Authorized Courses

Only courses listed in CAESAR (https://caesar.northwestern.edu) with a career of “The Graduate School” are authorized for graduate credit and only those courses can be used to meet the minimum coursework requirement of nine quality letter-graded, graduate level courses (i.e., ABC grading, not P/NP or S/U). Courses are arranged in levels designated by number:

- 300-level courses are primarily for advanced undergraduate students; some 300 level courses are approved for graduate credit.
- 400-level courses or seminars are primarily for graduate students, but the major part of the work is not research.
- 500-level courses are graduate courses in which the work is primarily research done by an individual student under faculty direction.

The number following the three-digit course number indicates whether the course is part of a sequence:

- 0 = one-quarter course
- 1,2 = two-quarter sequence
- 1,2,3 = three-quarter sequence

The number of units for which a student is registered determines if a student is in full-time status. Most courses carry one unit. Students are considered to be full-time if they are registered for at least three units of credit.

Some registrations (e.g., 499 Independent Study or Projects and 590 Research courses) allow the student to register for anywhere from one to four units for the course. By registering for such courses for a total of three to four units, it is possible for a student to take only one or two courses and still be considered full-time.

TGS General Registrations

General courses of The Graduate School are designated with a subject code, “TGS.” These TGS General Registrations are not graded and do not carry academic credit.

TGS 500-0 Advanced Doctoral Study

Available to doctoral students who are primarily doing research and are receiving funding. Provides full-time status. Students may register for TGS 500-0 Advanced Doctoral Study via CAESAR when they have completed coursework requirements or during summer quarters.

TGS 512-0 Continuous Registration

Available to students who have completed the program coursework and are continuing in their degree program (writing a thesis or dissertation and/or performing research required for the degree), but not receiving funding. TGS 512-0 Continuous Registration is a full time registration intended for students who are continuing to work in a full-time capacity toward degree completion.
TGS 512-0 Continuous Registration is $100/quarter and allows for:

- Continuation of the student’s Net ID and email account
- Access to University facilities such as libraries, labs, and sports facilities
- Maintenance of one’s visa status
- The ability to defer student loans
- The ability to take additional cost-of-living loans (federal and alternative) as determined by their financial state; and
- Ability to enroll in NU-SHIP (Northwestern University Student Health Insurance) and be charged the annual premium

Note that students enrolled in TGS 512-0 Continuous Registration:

- are not eligible for TGS Activity Fee or its attendant services, including legal services and U-Pass
- are not eligible for the health insurance subsidy
- may not register for any additional units of study
- must be making progress toward degree completion

TGS 588-0 Resident Master’s Study

Available to master’s degree students who are receiving funding administered by the University. Provides full-time status, but does not carry any units of credit. This registration requires The Graduate School’s permission. To request TGS 588-0 Resident Masters Study enrollment, Students should first consult with the program Director of Graduate Studies or adviser, then email gradservices@northwestern.edu.

Non-TGS Courses

Students may take courses outside of The Graduate School career. Courses not authorized for TGS credit do not count toward The Graduate School’s minimum coursework requirement.

- Students taking non-TGS graduate classes in the School of Education and Social Policy, McCormick School of Engineering, Bienen School of Music, School of Communication, or taking undergraduate classes may register using CAESAR by obtaining a permission number from the program offering the class.
- Registration for classes in other schools (https://www.registrar.northwestern.edu/registration-graduation/registration/cross-school-registration.html), including Kellogg School of Management, School of Professional Studies, and the Law School are handled through the respective schools’ registrars. To request enrollments in other schools, students should contact Student Services (gradservices@northwestern.edu).

Change of Registration

- Registration changes are permitted during the add/drop period, as published in the University’s academic calendar (https://www.registrar.northwestern.edu/calendars/academic-calendars). Students who fail to register for a fall, winter, or spring quarter will be automatically discontinued and must apply for readmission.
- Students may drop a course after the add/drop period and before the "last day to drop a course" deadline listed in the University Academic Calendar (https://www.registrar.northwestern.edu/calendars). Students may request to withdraw from a course (p. 11) after the drop deadline but before the withdrawal deadline listed in the University Academic Calendar (https://www.registrar.northwestern.edu/calendars).
- The University cannot give refunds or reduce tuition bills for any courses dropped after the fifth day of classes. See the Student Financial Services policy on enrollment changes (https://www.northwestern.edu/sfs/payments/enrollment-changes.html) for additional information.

Course Withdrawal

- A student may request permission from The Graduate School to withdraw from a course or courses after the published drop deadline (https://www.registrar.northwestern.edu/calendars) (the end of the sixth week of the quarter) until 5pm two Fridays before the published last day of classes, per the University Academic Calendar (https://www.registrar.northwestern.edu/calendars). When the Thanksgiving or other University holidays conflict with this deadline, withdrawal petitions must be submitted by the last class/business day of that same week. The University Academic Calendar (http://planitpurple.northwestern.edu/calendar/academic_calendar) lists the exact withdrawal deadline for each quarter.
- Students may not request withdrawal after the due date for the final assessment (exam, paper, project, etc.) has been reached. Students will be asked to attest that the due date for the final assessment (exam, paper, project, etc.) in the particular course(s) has not been reached, as that may fail before the deadline for withdrawal. Students who request withdrawal after the final assessment date has been reached will be in violation of the policy on academic integrity (https://www.northwestern.edu/provost/policies/academic-integrity/principles.html).
- All approved withdrawals will result in a W (withdrawal) grade being posted to the transcript. A grade of W does not factor into the GPA, but remains permanently on the transcript. In no case will tuition be refunded when a student withdraws from a course or courses.
- If the deadline to withdraw has passed, students should consult with the class instructor about the option of taking an incomplete or how to best complete the course.
- To submit a request to withdraw from a course after the drop deadline students should submit the request form (https://websso.it.northwestern.edu/amserver/UI/Login?goto=https%3A%2F%2Fwww.forms.northwestern.edu%2Fform_templates%2FFillFormSection%2FF66). The form must be approved by both the student’s faculty adviser and the Director of Graduate Studies (DGS). Once the form is received and approved by The Graduate School, the course instructor(s) will be notified of the student’s withdrawal from the course.
- This process is distinct from requesting to withdraw entirely from the University (p. 23). Students in The Graduate School who wish to withdraw from their program and the University must submit the Program Withdrawal Request form via TGS Forms in GSTS (https://gsts.northwestern.edu).

Summer Registration

Students must register for summer quarter if they are:

- Receiving funding in the form of a stipend
- Advised to do so by the Office of International Student and Scholar Services (https://www.northwestern.edu/international) in order to maintain their visa status
- Advised to do so by the Graduate Financial Aid office (https://www.northwestern.edu/evanston-graduate-financial-aid) in order to receive or defer loans
Auditing

Students in The Graduate School do not have the option to register for courses as auditors.

Continuous Registration Policy

All active students in The Graduate School must be registered at Northwestern University in each of the fall, winter and spring quarters until all degree requirements have been completed. (See the master’s (p. 14) and PhD (p. 17) sections of this catalog for information about degree completion.) Students who are working toward degree completion but are not required to enroll in coursework may register for the appropriate TGS general registration (p. 10). Students on an approved leave of absence (https://www.tgs.northwestern.edu/about/policies/leaves-of-absence.html) are not subject to the continuous registration policy during the leave period.

Taking Courses at Other Universities (Traveling Scholar Program)

Students who wish to register at other universities for classes that are not available at their home institution may do so via two programs:

- Big Ten Academic Alliance (BTAA) Traveling Scholar Program (https://www.btaa.org/resources-for/students/traveling-scholar-program/introduction)
- Chicago Metropolitan Exchange Program (CMEP) (https://grad.uic.edu/chicago-metropolitan-exchange-program)

General Rules and Procedures for Traveling Scholars

- Students who wish to take courses at other universities through the CME or BTAA programs must be enrolled full-time in a PhD program at Northwestern.
- Students may only take classes at host institutions that are not offered at the home institution.
- Eligible students must first consult with their adviser who will determine whether the off-campus opportunity is likely to enhance the student’s course of study and ascertain that it is not, in fact, available on the home campus.
- The student’s home adviser and the host campus faculty contact must agree to allow the student to enroll in a course via the Traveling Scholar Program before the student submits the online application.
- Traveling scholars remain registered at their home universities, paying the regular tuition and fees charged when they are in residence. Traveling scholars are not billed tuition by the host institution, but may be assessed fees for certain services or benefits.
- Credit earned by traveling scholars is accepted by Northwestern University for the equivalent level credit upon receipt of grade reports or transcripts from the host university. Credit toward a degree will be at the discretion of the student’s academic program.
- Visits of traveling scholars may not exceed two semesters or three quarters regardless of the number of courses taken.
- Students must submit the appropriate application form at least six weeks before the start of the course:
  - Big Ten Academic Alliance (BTAA) Traveling Scholar program application (https://www-s.cic.net/OnlineApplications/ts/tsapp) (for Northwestern University students who wish to attend a course at University of Chicago or a Big Ten Academic Alliance institution)
  - Chicago Metropolitan Exchange Program (CMEP) application (https://uofi.app.box.com/s/mbltn13bkocu46fyus17rqvrzs96rc6)

Grades and Grade Requirements

Students in The Graduate School must maintain a minimum cumulative GPA of 3.0. Grades given for completed, credit-bearing graduate courses not taken on a pass/no credit (P/N) basis are:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0</td>
</tr>
<tr>
<td>A-</td>
<td>3.7</td>
</tr>
<tr>
<td>B+</td>
<td>3.3</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
</tr>
<tr>
<td>B-</td>
<td>2.7</td>
</tr>
<tr>
<td>C+</td>
<td>2.3</td>
</tr>
<tr>
<td>C</td>
<td>2.0</td>
</tr>
<tr>
<td>C-</td>
<td>1.7</td>
</tr>
<tr>
<td>F\footnote{1}</td>
<td>0</td>
</tr>
</tbody>
</table>

\footnote{1} Failed to earn credit: work incomplete

X\footnote{1} Failed to earn credit: missed final examination

Y\footnote{1} Failed to earn credit: work incomplete

\footnote{1} Note that X, Y, NR, and F grades do not count toward the minimum coursework required for a degree.

The following notations are ignored in computing the grade point average:

- P: Pass with credit
- N: No grade, no credit
- K: In progress
- S: Satisfactory: noncredit course
- U: Unsatisfactory: noncredit course
- W: Withdrawn by permission
• NR: No grade reported by instructor
• X, Y: Incomplete

**Pass/No Credit Option**
Students will follow individual program requirements regarding graded coursework. Courses may be taken Pass/No Pass (P/N) only when this grading basis is available for selection in CAESAR. No individual exceptions will be allowed.

• 590 research registrations must be taken on a P/N basis. A grade of K (in progress), not a Y (incomplete), is given when the work for 590 is in progress.

**Incomplete Grades**
A grade of Y may be given when a student does not submit all assigned work in a course; a grade of X may be given when a student fails to take the final examination. It is up to the course instructor to determine whether an incomplete (X or Y) grade is appropriate. Typically, a grade of Y or X is reserved for students who experience extraordinary, catastrophic events beyond their control and is assigned only in extreme and unusual cases.

Students should make up incomplete work within one calendar year for a class in which an X or Y grade has been assigned. Course instructors and/or individual academic programs may impose stricter timelines for completing work. Outstanding incomplete (X or Y) grades may lead to probation and/or may prevent graduation.

**Graduation and Diploma Mailing**

**Degree Awarding**
Degrees are awarded in December, March, June, and August/September. Students should refer to the master's degree completion (p. 14) and PhD degree completion (p. 17) sections of this catalog for filing requirements.

Deadlines related to graduation can be found on the academic calendar (https://www.registrar.northwestern.edu/calendars/academic-calendars).

**Diploma Mailing**
Diplomas are mailed to the address indicated on the Application for Degree form. If the diploma mailing address changes between the time the form is submitted and degree awarding, students may update the address on the previously submitted Application for Degree in the TGS Forms tab in GSTS (https://gsts.northwestern.edu). Diplomas are mailed approximately four to six weeks following the date of degree awarding:

<table>
<thead>
<tr>
<th>Degree Awarded</th>
<th>Diploma Mailed</th>
</tr>
</thead>
<tbody>
<tr>
<td>December</td>
<td>mid January - early February</td>
</tr>
<tr>
<td>March</td>
<td>mid April - early May</td>
</tr>
<tr>
<td>June</td>
<td>mid July - early August</td>
</tr>
<tr>
<td>August</td>
<td>mid September - early October</td>
</tr>
</tbody>
</table>

**Certificates of Completion**
Students who require proof of degree completion prior to the date of degree awarding or prior to diploma mailing may request a Certificate of Completion. Assuming all degree requirements have been met, a Certificate of Completion can be generated in 1-2 business days. To request a Certificate of Completion, students should:

• Make sure that all degree requirements have been met. Refer to the master's degree completion (p. 14) and PhD degree completion (p. 17) sections of this catalog for specific requirements.
• Send an email to gradservices@northwestern.edu that contains the following information: Name, student ID, address (email or US Mail) where certificate should be sent.

Following the date of degree conferral, confirmation of degree completion can be requested via an official transcript through the Office of the Registrar (https://www.registrar.northwestern.edu/records/transcripts-verification/request-transcript.html).

**Leaves of Absence**
Leaves of absence are defined as a temporary separation from the University for a minimum of one quarter and a maximum of one year. Students who need to interrupt their progress towards degree may petition for a leave of absence. There are three types of leaves:

• Medical Leave of Absence (p. 14): For students who must temporarily interrupt progress toward degree due to a physical or mental health condition.
• Family Leave of Absence (p. 14): For students who must temporarily interrupt progress toward degree to extend absence post-childbirth, care for a newborn, adopt a child, or care for a family member. This leave of absence is separate from the parental accommodation policy (p. 15) and may be taken in addition to a parental accommodation. The parental accommodation is not considered a leave of absence. Please see the parental accommodation policy (p. 15).
• General Leave of Absence (p. 14): For students who elect to temporarily interrupt their progress toward degree for a non-medical/non-family care reason

**Leave of Absence General Policies**
All leaves of absence must be approved by the appropriate University offices/programs. The procedure for requesting a leave and the specific approvals required depend on the type of leave. The general policies that apply to all leaves of absence are:

• General and family leaves of absence are granted for no less than one quarter and no more than one year. Medical leaves are generally granted for a minimum of two quarters.
• No leaves will be granted retroactively. Mid-quarter leaves of absence with an "Effective Date" through the end of the sixth week of classes will result in an entry on the transcript documenting the withdrawal date. Leaves of absence with an "Effective Date" after the end of the sixth week will result in withdrawn courses, with grades of "W", being posted on the transcript along with the withdrawal date.
• Medical leaves of absence must be requested by the deadlines established by the Dean of Students office (https://www.northwestern.edu/studentaffairs/dos/programs-services/medical-leave-of-absence/determination-deadlines). General and family leaves may be requested in the current quarter before the course withdrawal deadline for that quarter (as published in the University's academic calendar (https://www.registrar.northwestern.edu/calendars/academic-calendars)), but not after the due date has been reached for the final assessment for any one course in which a student is enrolled.
• During a leave of absence, students are not permitted to enroll at the University and will not be considered active students.

• Students on a leave of absence are not to fulfill any degree requirements during the time on leave. If a student plans to be away from the University to work on a thesis, dissertation, or other degree requirements, this would not constitute a leave of absence and would require enrollment.

• International students who apply for a leave of absence must consult with the Office of International Student and Scholar Services. (https://www.northwestern.edu/international) International students taking a leave of absence for medical reasons (and with documentation from a healthcare provider) will need to receive approval from the Office of International Student and Scholar Services (https://www.northwestern.edu/international) and may be eligible to remain in the country for a period of time while on leave. International students taking a leave for non-medical reasons may have their status terminated and may need to depart the U.S.

• Students on an approved leave of absence are not eligible for federal financial aid, including Federal Direct Loans. In some cases, student loans may not be deferred for the entirety of a leave. Students should contact Graduate Financial Aid (https://www.northwestern.edu/evanston-graduate-financial-aid) for additional information.

• Approved leaves of absence automatically extend milestone deadlines by the length of the leave. This includes the qualifying exam deadline and prospectus deadline for PhD students, and the degree deadline for Master’s and PhD students. Leaves of absence do not extend deadlines that have passed as of the date the leave goes into effect, nor exempt students from meeting TGS degree requirements.

• A student on a leave of absence has limited access to University facilities normally available to enrolled students, including:

  • NetID: The NetID will be deactivated after a period of time following the start of the leave of absence, following the NUIT NetID Expiration schedule (https://www.it.northwestern.edu/netid/expiration.html).

  • Library: Students on a leave of absence may obtain a Borrower’s Card (https://www.library.northwestern.edu/visit/visitor-privileges/reciprocal-university/northwestern-borrowers.html) to access the University Library if needed and approved.

  • Health Insurance: Students who are on an approved leave of absence are permitted to remain enrolled in NU-SHIP for the year in which they start on a leave and elect to re-enroll for one subsequent year. Students may apply for coverage in the fall quarter through the Health Insurance Office (https://www.northwestern.edu/student-insurance/forms-resources/nu-ship-forms). Students who elect to re-enroll for a subsequent year are not eligible for the health insurance subsidy.

  • University Housing: Students taking a leave of absence who reside in University Housing must contact the Graduate Housing Office (https://www.northwestern.edu/living) as soon as possible to determine what options are available during the leave of absence.

  • Students on leave of absence must request return in advance of the quarter in which they wish to return. Instructions and the timeline for requesting a return from leave are detailed below.

  • Students who fail to petition to return after a leave of absence will be withdrawn (discontinued) from The Graduate School and need to apply for readmission (p. 19) in order to return.

Medical Leave of Absence
A student who must temporarily interrupt their progress toward degree due to a physical or mental health need must petition for a medical leave of absence. Medical leaves of absence are initiated through the Dean of Students Office (https://www.northwestern.edu/studentaffairs/dos/programs-services/medical-leave-of-absence). The process for a student to request a medical leave of absence is outlined on the Dean of Students, Medical Leave of Absence website (https://www.northwestern.edu/studentaffairs/dos/programs-services/medical-leave-of-absence).

Family Leave of Absence
A student who must temporarily interrupt progress toward degree to extend absence post-childbirth (https://www.tgs.northwestern.edu/about/policies/childbirth-accomodation.html), care for a newborn, adopt a child, or care for a family member should petition for a family leave. Family leaves of absence must be approved by the student’s program of study and The Graduate School. International students on a visa must also have their leave approved by the Office of International Student and Scholar Services (https://www.northwestern.edu/international). The process to petition for a family leave of absence is as follows:

• Student must submit the “Petition for Absence” form via TGS Forms in GSTS (https://gsts.northwestern.edu). The program’s DGS (or DGS designate) will review the form, after which The Graduate School will review.

• The Graduate School will notify the student (and the program) of the approval status.

• The student must petition for reinstatement by contacting TGS student services (gradservices@northwestern.edu) via email at least 6 weeks before the start of the quarter in which they plan to return.

General Leave of Absence
A student who wishes to temporarily interrupt their progress toward degree for a non-medical/non-family care reason may petition for a general leave of absence. General leaves of absence must be approved by the student’s program of study and The Graduate School. International students on a visa must also have their leave approved by the Office of International Student and Scholar Services (https://www.northwestern.edu/international). The process to petition for a general leave of absence is as follows:

• Student must submit the “Petition for Absence” form via TGS Forms in GSTS (https://gsts.northwestern.edu). The program’s Director of Graduate Studies (DGS) or DGS designate will review the form, after which The Graduate School will review.

• The Graduate School will notify the student (and the program) of the approval status.

• The student must petition for reinstatement by contacting TGS student services (gradservices@northwestern.edu) via email at least 6 weeks before the start of the quarter in which they plan to return.

Master’s Degree Requirements
The Graduate School at Northwestern University offers the degrees of:

• Master of Arts (MA)

• Master of Science (MS)
• Master of Public Health (MPH)
• Master of Fine Arts (MFA)

All Northwestern University graduate students must fulfill a set of requirements regarding:

• Approved coursework (p. 10)
• Grades (p. 10)
• Filing for graduation (p. 15)

Each student’s program of study for a master’s degree must be approved by the student’s academic program. Each student enrolled in a master’s program must have a committee and an adviser who advise on plan of study, degree requirements, and thesis and/or final exam, if required. The adviser and at least two of the master’s committee members must be members of the Northwestern University Graduate Faculty. In addition to requirements directly related to awarding of a degree, all students are required to maintain satisfactory academic progress and standards of academic integrity (p. 7).

Registration and changes of academic program regulations apply to all students across degree programs and disciplines. These policies are subject to change without notice.

**Master’s Courses**

To be eligible for a master’s degree, a student must successfully complete at least nine quality letter-graded courses (ABC, not P/NP or S/U) authorized for graduate credit (p. 10).

Credit earned at an undergraduate institution or at another graduate school or a professional school may, with program approval, be applied toward the program’s coursework requirements, but not toward The Graduate School’s minimum coursework requirement. Specific course requirements for the master’s degree are listed on each program’s website.

No more than one-third of the total units presented for the master’s degree may be 499 Independent Study.

Combined bachelor’s/master’s (accelerated master’s) students are permitted to count a maximum of three courses authorized for graduate credit toward both the undergraduate and graduate degrees. Certain programs may have more strict requirements. Students should speak with both the undergraduate and graduate programs about the possibility of double counting up to three units of coursework.

**Master’s Timeline**

Students must complete all the requirements for the master’s degree within five years of the date of their initial registration in The Graduate School, which falls on the last day of the 20th quarter. Students who do not complete their degree within five years will not be considered in good academic standing and will be placed on academic probation by The Graduate School, which falls on the last day of the 20th quarter. Students who do not complete their degree within five years will not be considered in good academic standing and will be placed on academic probation by The Graduate School, which falls on the last day of the 20th quarter. Students who do not complete their degree within five years will not be considered in good academic standing and will be placed on academic probation by The Graduate School, which falls on the last day of the 20th quarter. 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School who experience the birth or adoption of a child for whom they have parental responsibilities.

- Those adopting children over the age of 18 or a spouse’s or partner’s child are not covered by this policy.
- Those residing in localities where legal adoption is not an option but who are assuming parental responsibilities and otherwise meet the eligibility criteria are covered by this policy.

Students are eligible who have not utilized a parental accommodation during the previous 12 months before the requested accommodation start date.

**Accommodation Options**

Accommodation options vary with the student’s funding status and funding source:

- Funded graduate students (graduate assistants, research assistants, teaching assistants, trainees, fellows) who would receive tuition and stipend from the University as of the start of the accommodation period, as well as graduate students who are funded from an external source, may request paid leave from their duties for a 12 week accommodation period.
  - Funding will be provided by The Graduate School for the 12 week accommodation period. Funding will be applied in the months closest to the dates of the accommodation.
  - If a student is not receiving funding as of the start date of the parental accommodation, none will be provided by this accommodation.
  - Graduate students who are funded from an external source supported on external fellowships or awards are obliged to inform their funding agency and should consult TGS Student Funding (tgs-fa@northwestern.edu).
- Unfunded graduate students (those who are not receiving funding as of the start date of the parental accommodation) may request unpaid leave from their studies for up to a 12 week accommodation period.

Either option will result in the extension of future TGS milestone deadlines (qualifying exam, prospectus, and degree deadline) by one year (four quarters). Programs must extend future, program-specific deadlines by the same length. Students, Directors of Graduate Studies (DGSes) and advisers are expected to discuss a timeline for meeting requirements well in advance of the start of the accommodation period.

To ensure that programs have ample time to arrange coverage during the accommodation, students must request the accommodation at least 60 days in advance of the accommodation start date. In unforeseen circumstances, students must provide as much notice as possible.

**Stipulations**

- Individual students may request one accommodation per childbirth or adoption event.
- Students who have had a prior parental accommodation within the past 12 months may not request another accommodation, but may request a medical or family leave of absence.
- Students must begin the accommodation period within the first 90 days of the birth or adoption, or prior to the birth/adoption if medically necessary.
- The period of accommodation applies to calendar weeks. If a Parental Accommodation overlaps with an academic break, the break period will still count toward the 12-week period of accommodation.
- Whichever accommodation option students choose, students will be eligible to maintain their student health insurance. Depending on a student’s funding status, the health insurance subsidy may or may not be applied. If the health insurance subsidy is not applied, a student will have the option to purchase coverage in fall quarter and may be eligible for a prorated subsidy depending on timing of return and funding status at the time of return. The Graduate School’s Student Services (https://www.tgs.northwestern.edu/about/contact) representatives will be able to assist in this process.
- Students may wish to utilize a Leave of Absence in addition to (either before or after) a Parental Accommodation. Students who require medically necessary time away due to pregnancy or childbirth may request a Medical Leave of Absence. Students who wish to have additional time for the care of a child may request a Family Leave of Absence. See the Leave of Absence policy (p. 13) for additional information.
- Students who are enrolled in classes at the time of an accommodation must work with their instructors to determine whether incomplete grades are possible and to arrange a timeline for completion of coursework upon return from the accommodation period. If a student anticipates taking parental accommodation for a partial quarter, it is recommended that the student not enroll in coursework. Students should consult TGS Student Services (gradservices@northwestern.edu) to determine how to register for the quarters surrounding a parental accommodation.
- Students who are utilizing a parental accommodation may not fulfill degree requirements or make significant progress toward degree during the accommodation period. Programs (including instructors and advisers) may not require fulfillment of requirements or progress toward degree completion during the accommodation period.

**Procedures**

- Eligible students will request a Parental Accommodation by submitting the “Petition for Absence” form via TGS Forms in GSTS (https://gsts.northwestern.edu) and selecting the parental accommodation option at least 60 days prior to the accommodation start date (or as soon as possible in unforeseen circumstances).
- The program’s Director of Graduate Studies (DGS) or DGS designate will review the form, after which The Graduate School will review.
- When approved, The Graduate School will update the student’s record and the form will be sent to the program’s Student Services (gradservices@northwestern.edu) to determine how to register for the quarters surrounding a parental accommodation.
- At the end of the 12 week period, students will resume their studies. If additional time away is needed, students must file for the appropriate leave of absence.
  - If students wish to return prior to the end of the 12 week period, they must first consult with The Graduate School Student Services (gradservices@northwestern.edu).

**Patent and Invention Policy**

Any invention or discovery by an individual, including a student, who (1) made the invention or discovery within the normal field of his or her employment responsibility and activity with the University, without regard to location or salary source (specifically including individuals employed at affiliated hospitals and institutions), or (2) makes use of Northwestern University Resources, except library, is subject to the provisions of the University Patent and Invention Policy and thus owned by the University.
PhD Degree Requirements

The only doctoral degree offered by The Graduate School is the doctor of philosophy (PhD) degree. In some cases, this degree is offered in conjunction with another degree through an approved dual degree program, whether from another program administered by The Graduate School, from another school at Northwestern University, or through an agreement with a partner University.

The Doctor of Philosophy degree is oriented toward research that will advance knowledge. Study for a specified time and accumulation of credit for courses taken are not by themselves sufficient to earn the PhD degree. A student must demonstrate scholarly distinction and the ability to advance knowledge through independent research by achieving admission to candidacy and writing a dissertation.

Each student enrolled in a PhD program must have a principal research adviser and a committee.

The principal research adviser (also known as mentor, PI, dissertation director, adviser) is a member of the Northwestern University Graduate Faculty who works with the student to develop a research topic, formulate ideas and structure for, and guides the progress of the thesis/prospectus/dissertation. In some cases, although rare, there is a principal research co-adviser who also works with the student to develop a research topic, formulate ideas and structure for, and guides the progress of the thesis/prospectus/dissertation.

The committee members are those who have expertise in and inform the student's area of research, serve as a reader of the thesis, prospectus, or dissertation, and vote on the outcome of the proposal defense/final exam. The committee chair is a member of the Graduate Faculty who leads the committee for the defense of the prospectus or PhD final exam (dissertation). In some cases, there is a committee co-chair who co-leads the committee. The committee chair may or may not be the same individual as the principal research adviser. A minimum of three individuals must serve on the final exam committee. At least two members of this committee, including the chair, must be members of the Northwestern University Graduate Faculty.

All Northwestern University graduate students, must fulfill a set of requirements regarding

- approved courses (p. 17) and grades (p. 10)
- qualifying exam (admission to candidacy) (p. 17)
- prospectus (p. 17)
- filing for graduation (p. 18)
- dissertation (p. 18)

PhD Coursework and Registration

A student who enters a doctoral program must successfully complete at least nine quality letter-graded courses (ABC, not P/NP or S/U) authorized for graduate credit. Students must maintain a 3.0 cumulative GPA. The Graduate School does not accept transfer credit in lieu of the nine letter-graded minimum course requirement.

Two types of advanced courses, 499 Independent Study (or 499 Projects) and 590 Research bear restrictions:

- 499 Independent Study - For doctoral students, independent studies may not represent more than half of the total units taken in the first three quarters of enrollment in a PhD program.
- 590 Research - Departmental 590 research may be taken for one, two, three, or four course units per quarter. All 590 Research registrations must be taken on a P/N/K basis.

All coursework requirements for a doctoral program are expected to be completed by the end of the 12th quarter. Students who are funded and who register for less than three course and/or research units in any given quarter must also register for TGS 500-0 Advanced Doctoral Study.

Students in quarters 13 and beyond may register for non-required coursework in addition to TGS 500-0 Advanced Doctoral Study if the courses are related to the student’s area of study.

No credit will be awarded by The Graduate School for work completed in a graduate program prior to admission to and enrollment in the PhD program in The Graduate School. Individual programs may waive program-specific course requirements based on work completed outside of the graduate program (either prior to or after enrollment at Northwestern), but all doctoral students must complete nine quality letter-graded (ABC) courses authorized by The Graduate School for graduate credit and maintain at least a 3.0 cumulative GPA.

PhD Candidacy

Admission to The Graduate School does not constitute or guarantee a student’s admission to candidacy for the PhD degree. Admission to candidacy is contingent upon the recommendation of the student’s program and upon approval of The Graduate School.

A student must be admitted to candidacy by the end of the third year of study. A student failing to meet this milestone will be considered not in good academic standing and therefore will be placed on academic probation (p. 19). Deadlines will be altered in the case of an approved leave of absence or parental accommodation.

- Admission to candidacy is reached by passing a comprehensive qualifying examination, written or oral or both. Individual departments or programs determine the character of this examination. At the time of admission to candidacy, proficiency in the major and related fields is certified and additional requirements for the PhD degree are stipulated. Students should be aware of requirements for admission to candidacy established by both the program and the Graduate Faculty.
- The student submits the PhD qualifying exam form online via TGS Forms in GSTS (https://gsts.northwestern.edu). The Director of Graduate Studies (or DGS designate) must submit approval of this form before the end of a student’s third year of enrollment in the PhD program. Following the submission of the approved qualifying exam form students are admitted to candidacy. Students are notified via email by TGS of approval of their qualifying exam form and admission to candidacy.

PhD Prospectus

Students must have a prospectus (dissertation proposal) approved by their committee no later than the end of the fourth year of study, which falls on the last date of the 16th quarter. A student failing to meet this milestone will be considered not in good academic standing and therefore will be placed on academic probation (p. 19). Deadlines will be altered in the case of an approved leave of absence or parental accommodation.

Visit the Innovation and New Ventures Office’s website for further details (https://www.invo.northwestern.edu/invention-disclosure).
accommodation. The prospectus must be approved by a faculty committee. A minimum of three individuals must serve on the prospectus committee. At least two members of this committee, including the chair, must be members of the Northwestern University Graduate Faculty. The student must submit the PhD prospectus form through TGS Forms in GSTS (https://gsts.northwestern.edu). The program must approve this form online before The Graduate School enters the final approval. Students are notified via email by The Graduate School of approval of their prospectus form.

PhD Dissertation

Every candidate for the PhD degree must present a dissertation that gives evidence of original and significant research.

Dissertation Assistance

All dissertators should consult with their advisers about appropriate forms of assistance before assistance is rendered. Dissertations must acknowledge assistance received in any of the following areas:

- Designing the research
- Executing the research
- Analyzing the data
- Interpreting the data/research
- Writing, proofing, or copyediting the manuscript

Formatting

Dissertations must be formatted according to the Dissertation Formatting Guidelines document (https://www.tgs.northwestern.edu/documents/policies/dissertation-format-guidelines.pdf). Dissertations not conforming to these instructions will not be accepted by The Graduate School.

Depositing the Dissertation

Dissertations must be deposited into the ProQuest Database (https://www.etdadmin.com/cgi-bin/home). In addition, the University Library receives a copy of the dissertation that may be used at its discretion for reasons including but not limited to long term archiving, library use and interlibrary loan, and dissemination through an institutional repository or other means. The library also archives electronic copies of dissertations to help ensure that the content is preserved for future generations.

Dissertation Embargo

With the permission of a faculty member well-versed with the student's work, presumably the primary adviser, students may request to embargo (delay release of) their dissertation for a period of six months, one year, or two years. To request an embargo, the student must submit the Dissertation Embargo (Delayed Release) Request form (https://websso.it.northwestern.edu/amserver/UI/Login?goto=https%3A%2F%2Fwww.forms.northwestern.edu%2Fform_templates%2FfillFormSection%2F57) and provide a clearly stated rationale. The faculty mentor must approve the request and provide a brief rationale for the approval of the embargo request.

An approved request to place an embargo has the effect of restricting online access to the dissertation through the library's discovery systems and ProQuest for the period of the embargo. Metadata (author, title, abstract, keywords and subjects) about the embargoed dissertation will be available through the ProQuest system and the library catalog. Users of those systems are able to search for and see the metadata, but not the actual text or other content of the dissertation.

The dissertation will automatically be released in the library's discovery systems (https://www.library.northwestern.edu/libraries-collections/digital-collections) and ProQuest (https://www.etdadmin.com/cgi-bin/home) after the approved embargo expires. To extend the embargo with ProQuest (https://www.etdadmin.com/cgi-bin/home), students should contact ProQuest Support (https://www.etdadmin.com/cgi-bin/main/support) directly. To extend the embargo with the University Library, students must contact The Graduate School Student Services (gradservices@northwestern.edu) at least thirty days prior to the point of expiration. The student may request a one-time extension of the embargo for up to six years and must provide a sufficient intellectual and/or professional rationale in seeking approval from The Graduate School.

PhD Completion

Scheduling the final examination (dissertation defense) is the responsibility of the candidate and the members of the committee.

- The PhD final exam must be approved by a faculty committee. A minimum of three individuals must serve on the final exam committee. At least two members of this committee, including the chair, must be members of the Northwestern University Graduate Faculty.

Filing Requirements and Forms

Students pursuing the Doctor of Philosophy degree must file the following required documents prior to graduation and by the published deadlines (https://www.registrar.northwestern.edu/calendars/academic-calendars):

- Application for Degree: this form must be filled out via GSTS (https://gsts.northwestern.edu). Students should login to GSTS (https://gsts.northwestern.edu), click on the "TGS Forms" tab and create a new "Application for a Degree" form.
- PhD Final Exam Form: this form must be filled out via GSTS (https://gsts.northwestern.edu). Students should login to GSTS (https://gsts.northwestern.edu), click on the "TGS Forms" tab and create a new "TGS PhD Final Exam" form.
  - Each PhD Final Exam committee member must approve the form after the final exam (defense) date. Committee members render their approval by clicking the embedded link in the email they automatically receive once the exam date passes.
- Dissertation submission via ProQuest's website (https://www.etdadmin.com/cgi-bin/home). Once the dissertation has been approved by the committee and all edits and revisions are complete, the student must submit online via ProQuest. The dissertation must conform to The Graduate School formatting standards on the Dissertation Formatting Guidelines document (https://www.tgs.northwestern.edu/documents/policies/dissertation-formatting-guidelines.pdf). Once the student has submitted the dissertation online, a Student Services representative will review its formatting and confirm via email that the dissertation is acceptable or notify the student if changes need to be made.
- Change of Grade forms: Students with incomplete grades (Y, X, K, or NR) on their transcript must work with their program/department to ensure the appropriate change of grade forms are submitted to The Graduate School by the published deadline.

PhD Timeline

All requirements for the doctoral degree must be met within nine years of initial registration in a doctoral program, which falls on the last day of the 36th quarter. For students on an approved leave of absence (https://
Program Transfer

A student who wishes to transfer from one program to another within The Graduate School must submit an online application (https://www.applyweb.com/nugrad) (making sure to respond accurately to the first page of questions) no less than two weeks before the start of the winter, spring and summer quarters and no less than four weeks before the start of the fall quarter. Programs may require supporting materials in order to consider the request. Approval is granted by The Graduate School in consultation with the program into which the student is requesting a transfer. University funding awarded by the student’s current program will not follow the student to the new program.

Readmission

Degree-seeking students who miss one or more quarters of registration (excluding summer), who fail to request return after an approved period of leave of absence, or who request to withdraw from their program will be discontinued from The Graduate School. Those who are discontinued are not enrolled and are not considered active students. Students who fall into this category and who wish to return to the University must submit an online application (https://www.applyweb.com/nugrad) no less than two weeks before the start of the winter, spring and summer quarters and no less than four weeks before the start of the fall quarter and be sure to accurately respond to the first page of questions on the application. The decision to readmit a former student is at the discretion of the program and The Graduate School.

Those who have previously been enrolled in The Graduate School at Northwestern University as degree-seeking students but have had a break in their enrollment resulting from withdrawal or failure to continuously register will be subject to a readmission fee of $250 plus $100 for each fall, winter, and spring missed quarter of enrollment up to a cap of $1000.

Students who are awarded a degree from The Graduate School and apply for readmission to pursue another degree in The Graduate School are not assessed a readmission fee.

Students in the bachelor’s/master’s combined degree program who do not continue in the master’s program following conferral of the bachelor’s may apply for readmission within five years of admittance to the combined degree program and will be assessed a $75 readmission fee.

Satisfactory Academic Progress

Cases of academic and/or research misconduct, discrimination or harassment, and inappropriate or unprofessional behavior are considered outside the boundaries of “satisfactory academic progress.” Resources for these issues can be found here:

- The Graduate School Academic Integrity policy (p. 7)
- Office for Research Integrity (http://www.researchintegrity.northwestern.edu)
- Office of Equal Opportunity and Access (https://www.northwestern.edu/equal-opportunity-access)
- Student Handbook (https://www.northwestern.edu/student-conduct/shared-assets/studenthandbook.pdf)
- Per federal regulation, recipients of federal financial aid must meet certain requirements (in addition to those listed below) to maintain satisfactory academic progress. Recipients of federal aid should be aware of the Federal Financial Aid Satisfactory Academic Progress Policy (https://www.northwestern.edu/sfs/documents/publications_and_forms/SAP%20Policy%20TGS.pdf).

Criteria for Satisfactory Academic Progress

The Graduate School sets the minimum standard for satisfactory academic progress. Programs may impose additional criteria beyond The Graduate School’s for determining a student’s academic standing.

There are three sets of criteria that The Graduate School takes into account in determining whether or not students are making satisfactory academic progress:

- Grades and cumulative GPA: A student whose overall (cumulative) grade average is below B (3.0 GPA) or who has more than three incomplete (Y or X) grades is not making satisfactory academic progress and will be placed on probation by The Graduate School. Individual programs may have stricter criteria and can determine independently from The Graduate School that a student is not meeting grade and/or cumulative GPA requirements in the program.
- Milestone deadlines: Doctoral students who have not been admitted to candidacy (have not passed the qualifying exam) by the end of their third year, or who have not completed the dissertation proposal (prospectus) by the end of the fourth year are not making satisfactory academic progress and will be placed on academic probation by The Graduate School. Individual programs may have earlier deadlines or additional milestones and can determine independently from The Graduate School that a student is not making satisfactory progress toward milestones.
- Program length: Doctoral students must complete all requirements for the PhD within nine years of initial registration (p. 17) in The Graduate School. Master’s students must complete all requirements for the master’s degree within five years of initial registration (p. 14) in The Graduate School. Students who do not complete degree requirements by the established deadlines will be placed on academic probation by The Graduate School. Individual programs may have stricter criteria for timely degree completion and can determine independently from The Graduate School that a student is not making satisfactory progress toward degree completion.

Programs may have criteria beyond The Graduate School’s criteria for determining a student’s academic standing. Examples of these additional criteria could include, but are not limited to: unsatisfactory performance in classes, unsatisfactory performance on qualifying exams, unsatisfactory research progress, unsatisfactory progress in writing the dissertation, failure to communicate with program and/or adviser, failure to have a primary research adviser, or failure to meet requirements outlined in a program’s handbook, annual progress communications or other direct communications to students from programs or advisers.

All programs must make clear and direct reference in their materials (in a printed handbook and/or on their website) to the policies detailed below, to the extent that they differ from The Graduate School’s policies, and any additional program requirements.
Each student’s academic progress must be reported at least annually by the student’s program in writing to the student and to The Graduate School.

Failure to make satisfactory academic progress as determined by either The Graduate School or the program will result in probation or exclusion (dismissal).

**The Graduate School’s Academic Probation**

When a student fails to meet any of the three sets of criteria established by The Graduate School for maintaining satisfactory academic progress, the student will be placed on probation by The Graduate School.

The Graduate School will notify the student in writing, along with the program’s Director of Graduate Studies, and will be given at most two quarters (not including summer quarter) to resume satisfactory academic standing. The Graduate School notifies students of probation status on a quarterly basis (excluding summer).

During The Graduate School-imposed probationary period, students will remain eligible to receive federal and institutional assistance (except when they have exceeded their degree deadline). At the end of the probationary period, progress will be reviewed by The Graduate School. If a student does not re-establish satisfactory academic standing during the two probationary quarters and does not successfully petition for an extension of the probationary period (p. 20), the student will become ineligible to receive financial aid and will be excluded (dismissed) from The Graduate School.

**Petitioning The Graduate School for an Extension of the Probationary Period**

Students who have not achieved The Graduate School’s minimum GPA requirement or exceeded The Graduate School’s milestones or degree deadlines and do not remediate within the two-quarter probationary period may petition The Graduate School for a one-time extension of the probation period.

Extensions of the probationary period will be granted only in exceptional circumstances when there are extraordinary reasons beyond the student’s control that have been discussed in advance of the probation deadline between the student and their program (faculty adviser and Director of Graduate Studies).

The petition must include:

- **The specific length** of the extension including the exact date by which the requirement will be met. The extension time frame should be realistic, as there is no opportunity for additional extension of the probationary period.
- A **rationale** for the extension that explains the extraordinary reason(s) the requirement could not be met by the deadline or within the two-quarter probationary period. Detailed personal information is not required, but some explanation of the delay is necessary for The Graduate School to consider a petition.
- A **detailed timeline** for meeting the requirement including what work remains to be completed and the specific timeline, with proposed deadlines by which that work will be completed within the extension period.
- A **detailed letter of support** for the extension from the student’s academic/research adviser that endorses the length of the extension, the timeline for meeting requirements, and addresses the feasibility of the plan.
- **Signatures** from the student’s academic/research adviser and the Director of Graduate Studies.

The petition must be submitted as one single **PDF** document to gradservices@northwestern.edu **seven (7) calendar days before the grading deadline of the last quarter of probation**, but no earlier than the first day of the last quarter of probation. Incomplete and/or late petitions will not be accepted.

**Program Probation**

As noted above, programs have additional criteria beyond The Graduate School’s three sets of criteria for determining a student’s academic standing. All programs must make clear and direct reference in their materials (in a printed handbook and/or on the web) to any additional criteria for determining a student’s academic standing and to the consequences of failing to meet program-specific requirements.

When a program determines that a student is not making adequate academic progress, the program may place the student on probation in accordance with the probation process outlined in the program’s handbook or in direct written communication to a student. Programs determine the length of the probationary period in accordance with their handbook or previous communication to a student. When a decision to place a student on probation is made by the program, the student and The Graduate School must be notified in writing.

**Exclusion (Dismissal)**

A student who fails to resume satisfactory academic standing during the probationary period after being notified of placement on probation by The Graduate School will be excluded (dismissed) from The Graduate School. The exclusion decision is final when The Graduate School excludes a student who does not meet one or more of The Graduate School’s three sets of criteria for satisfactory academic progress and who has failed to remediate within The Graduate School’s probationary period. In such cases, there is no process for appeal and the exclusion will take effect immediately.

As noted above, programs have additional criteria beyond The Graduate School’s three sets of criteria for determining a student’s academic standing and may have their own probation process. A student who has failed to make satisfactory academic progress according to the program-specific criteria, or failed to remediate during a program-specific probation period, will be excluded (dismissed) by the program. A student can be excluded (dismissed) by a program when:

- the criteria for exclusion (dismissal) have been stated clearly by the program, either in a handbook or via direct written communication to a student, and have been disseminated to the students effectively, and
- the decision to exclude is made by the program faculty or a subset of faculty which includes the Director of Graduate Study. No individual faculty member may exclude a student.

Funding will cease on the effective date of the exclusion unless other arrangements are made. When a student is excluded (dismissed) by the program, the student has an opportunity to appeal the exclusion decision (p. 21) to The Graduate School. When a student appeals the program’s exclusion decision, the student remains an active student.
while the appeal is under review. In the event the appeal is denied, the exclusion takes effect after the appeal process has concluded.

**Notification of Exclusion (Dismissal)**
When The Graduate School determines that a student is to be excluded, both the program and the student will be informed in writing (email communication is considered to be "in writing") within ten business days of the determination.

Similarly, when a decision to exclude a student is made by the program, both the student and The Graduate School must be informed in writing within ten business days of the decision. The exclusion (dismissal) notification must include the effective date of the exclusion and a clear statement of the reason(s) for exclusion.

**Appeal Process for Exclusions by Program**
Students wishing to appeal a program’s exclusion decision may appeal the final program exclusion decision to The Graduate School. To appeal a program decision, students should submit a request in writing to the attention of Student Services (gradservices@northwestern.edu) within ten calendar days of the date of the program’s final written determination of exclusion to the student and include any supporting materials at that time. If no appeal is filed within the ten-day appeal period, the program’s decision becomes final and not subject to appeal.

Grounds for appeal of a program’s exclusion decision are as follows:

- procedural errors in the exclusion process
- new information discovered after the exclusion that was not available at the time of the exclusion and could impact the outcome
- program’s decision to exclude was manifestly contrary to the weight of the information available at the time of the decision (i.e., exclusion is obviously unreasonable and unsupported by the great weight of information).

Appeals of program exclusions are reviewed by the Dean of The Graduate School (and/or the Dean’s designate) who may request additional information from, or a meeting with, the student and/or program before making a final decision. If the Dean (or the Dean’s designate) does not find that any of the aforementioned grounds for appeal are present, the Dean will uphold the outcome of the program. If the Dean (or the Dean’s designate) finds that grounds for appeal are valid, they may amend the decision of the program. The Dean’s decision will be made within 30 days of the submission of the appeal and will be communicated in writing to both the student and the program. When resolution cannot be achieved within 30 days, students and programs will be informed in writing of the delay and the final disposition will be achieved as quickly as possible. The Dean’s decision is final.

**Student Funding Policies**
All students in The Graduate School receiving financial support must be registered full time during the quarter(s) in which they receive funding, including summer.

**Regulations Governing Recipients of University Assistance**
Newly admitted applicants must use the online application tool to officially accept or decline the University’s offer of admission. The act of accepting admission also signifies the acceptance of the University’s financial award.

All recipients of University funding must meet the following conditions. If any of the conditions specified in this document are violated, financial assistance may be withdrawn by The Graduate School.

1. Submit to The Graduate School official transcripts listing all prior undergraduate and graduate coursework undertaken and degrees awarded.
2. Continuously register as a full-time graduate student.
3. Maintain at least a “B” average each quarter.
4. Keep records free of incomplete grades
5. Refrain from remunerative work, unless a request for permission to work is approved by The Graduate School (see section 19.2 below).
6. Notify the Graduate Student Funding office and home department (via email) of other sources of support, such as an external award, traineeship, teaching assistantship, research assistantship, School of Professional Studies teaching, or other fellowship. In cases where alternative funding is available, The Graduate School’s financial award may be adjusted.
7. Be aware that funding beyond five academic years is not guaranteed by TGS.
8. Adhere to all regulations as stipulated on The Graduate School website and in the University Student Handbook and their program’s Student Handbook.

**Summer Quarter**
Appropriate full time registrations for funded students in the summer quarter include:

- 3-4 units of coursework;
- TGS 588-0 Resident Masters Study; or
- TGS 500-0 Advanced Doctoral Study

The following documents pertain to all applicants for and recipients of any type of University assistance:

- Guidelines for Continuing Support for Multiyear Awards (https://www.tgs.northwestern.edu/documents/funding/guidelines_multiyear_awards.pdf)

**Permission To Work**
Graduate students are expected to be full-time students conducting their studies and research. On occasion another funding opportunity may arise. When that situation occurs permission to receive remuneration must be requested.

A Graduate Student Permission to work Request Form (https://websoo.it.northwestern.edu/amserver/UI/Login?goto=http%3A%2F%2Fwww.tgs.northwestern.edu%2Fresources-for%2Fstaff%2Ffunding%2Fgraduate-student-additional-pay-request-form.html) is required when students are receiving additional pay if any of the following conditions are met:
1. The graduate student’s service exceeds 10 hours/week.
2. The graduate student’s period of service exceeds one month.
3. The requested compensation is greater than or equal to $600.

If any of the above conditions are met, complete the form and submit it via one of the below methods. The form should be submitted BEFORE the work begins.

**Electronic Additional Pay in myHR**

1. Email the completed Graduate Student Permission to Work Request form to the Graduate Student Funding staff at tgs-fa@northwestern.edu. Some schools may require school level approval on the form as well. Other schools approve online during the Additional Pay Request workflow. Please check with your school for routing instructions.
2. If the request is approved, the signed form will be sent back to the requester.
3. Upload the signed form into the Additional Pay Request. Be sure to check any relevant check boxes regarding the student’s hours/week, length of service and total compensation.

**External Funding Directly to the Student**

1. If the student will be funded directly by an external source, email the completed Graduate Student Permission to Work Request form to the Graduate Student Funding staff at tgs-fa@northwestern.edu. Some schools may require school level approval as well. Please check with your school for routing instructions.
2. If the request is approved, the signed form will be sent back to the requester. The form should then be uploaded into the student’s record in GSTS.

Please contact Graduate Student Funding staff (tgs-fa@northwestern.edu) with any questions.

**TGS External Award Policy**

Graduate funding is a collaborative effort between students and Northwestern University. The Graduate School (TGS) strongly encourages every student to apply for funding from a source external to the University sometime prior to the end of their fourth year. While TGS understands that some disciplines and students may have fewer opportunities for external funding, we still expect PhD students in all programs to pursue external awards. Such awards offer students opportunities to hone their academic skills, secure funding, enhance their curriculum vitae and make invaluable academic contacts for the future.

To encourage and reward the pursuit of external funding opportunities, TGS will provide the following to students enrolled in PhD programs in the School of Education and Social Policy; the Bienen School of Music; the School of Communication (social sciences and humanities programs); and Divisions II and III of the Weinberg College of Arts and Sciences (the social sciences and humanities), Mathematics, and Statistics.

The provisions listed below apply to those awards that provide student comparable stipend support. Therefore, awards such as the doctoral dissertation research improvement grants (DDRIG), which provide only research and travel support, are not eligible for the support listed below.

1. A 1:1 match up to an additional four quarters of support to be used through the summer of the 6th year of support for graduate students who are awarded and accept an external competitive award within their first five years of study; and
2. A stipend supplement of $500 per month for the duration of the external award to students through their fifth year.
3. A stipend top-up to the TGS base stipend if the external award stipend is lower to students through their sixth year.

For students enrolled in MFA programs, The Graduate School will determine on an ad hoc basis to provide the stipend supplement of $500 per month and/or a stipend top up to the TGS base stipend if the external award stipend is lower.

**VA Pending Payment Policy**

For Northwestern students using U.S. Department of Veterans Affairs (VA) Post 9/11 G.I. Bill® (Ch. 33) or Vocational Rehabilitation and Employment (Ch. 31) benefits, the University will not prevent enrollment, assess a late fee, deny access to resources available to other students, or require they secure additional funding while payment from the United States Department of Veterans Affairs is pending to the University.

To qualify for this provision, students may be required to:
- Produce the VA’s Certificate of Eligibility by the first day of class;
- Provide written request to be certified;
- Provide additional information needed to properly certify the enrollment as described in other institutional policies.

**Student Handbook and Code of Conduct**

The Northwestern University Student Handbook (https://www.northwestern.edu/student-conduct/about-us/student-handbook/assets/student-handbook.pdf) describes the expectations for behavior and conduct in the Northwestern community and outlines the procedures to be followed when these expectations are not met.

**Teaching**

Teaching is an essential element of the education and training experience of PhD students at the university. TGS requires that all PhD students serve in some instructional capacity for at least one academic quarter during their graduate education at Northwestern.

- Academic programs may define the teaching responsibilities of their PhD students independently. This teaching experience should provide PhD students with an opportunity for direct contact with and to contribute to the assessment and evaluation of students.
- PhD students should have the opportunity to assist in course planning; however, TGS recognizes that this type of opportunity may not be practical in all instances.
- To ensure work-load equity both within and among programs, the type of teaching responsibilities required by programs should be approved in advance by the dean’s office of the relevant school and periodically monitored by TGS.
- No student currently enrolled in a TGS program should be responsible for the final assessment of any assignment, or the final grade, in coursework undertaken by another student enrolled in a TGS program. In rare cases where graduate students are involved in the instruction of other graduate students in credit-bearing courses peer to peer assessment must be done under close faculty supervision and faculty must take full responsibility for the final assessment of the
enrolled students. (This pertains to Master’s and PhD students teaching students in their own as well as other programs.)

• The teaching requirement is unrelated to a student’s source of funding.

Withdrawal

Students who wish to withdraw entirely from The Graduate School must complete the Program Withdrawal Request form via TGS Forms in GSTS (https://gsts.northwestern.edu). Per The Graduate School and the University’s withdrawal and refund policies, whether a tuition refund is possible and the amount of the refund depends on how long students were enrolled in the term. All tuition adjustments are computed as of the date on which the official withdrawal notice is received. Refunds of part or all of the tuition depend on the time the request is made, per the published refund schedule (https://www.northwestern.edu/sfs/payments/withdrawing-from-the-university).

Withdrawals in the fall, winter, and spring quarters with an "Effective Date" through the end of the sixth week of classes will result in an entry on the transcript documenting the withdrawal date. Withdrawals with an "Effective Date" after the end of the sixth week will result in the withdrawn courses, with grades of "W", being posted on the transcript along with the withdrawal date.
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**Accounting Information and Management**

[https://www.kellogg.northwestern.edu/faculty/academics/accounting.aspx](https://www.kellogg.northwestern.edu/faculty/academics/accounting.aspx)

**Degree Types:** PhD

The Accounting Information & Management doctoral program trains students in empirical/archival and analytical/theoretical research methods focusing on the role of accounting in the market for financial information. We prepare students to conduct research on the use of accounting information: 1) in the firm’s internal decision-making and performance evaluation functions; 2) in the contractual relationships between the firm and both internal and external parties; 3) in the functioning of capital markets and 4) by other stakeholders and potential stakeholders in the firm.

Accounting students receive rigorous training in the basic disciplines of economics and econometrics in addition to the more specialized areas of accounting and finance. The cross training our students receive in empirical and analytic research is one of the strengths of our program. Another major strength of our department is the collaboration between our faculty and PhD students on research projects, a collaboration that often begins within the first year.

Accounting is the language of business and its role is key in communicating financial information to all parties engaged in any type of commerce. Accounting research focuses on the decisions of what,
how, and to whom to communicate information and the consequences of these communications.

**Degrees Offered**

- Accounting Information and Management PhD (p. 27)

**Accounting Information and Management PhD**

**Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in *The Graduate School Policy Guide* (p. 7).

Requirements may also be found in the *Program Guidelines* for Accounting Information and Management PhD students that is issued by the Kellogg School of Management.

**Master’s Degree**

While the goal of our doctoral program is the awarding of a PhD degree, a Master of Science (MS) degree may be awarded to currently enrolled, qualified Kellogg doctoral students. Students who are continuing for a PhD degree, or students who withdraw from the PhD program, may be considered for one of two MS degree options noted below.

1. **MS in Managerial Economics & Strategy** – a minimum of three quarters of coursework and a “master’s pass” on the preliminary exam in microeconomics. Note: the student who wishes to obtain this degree must elect to take the preliminary microeconomics examination; this exam is not required otherwise.

2. **MS in Accounting Information & Management** – a minimum of six quarters of coursework and a “master’s pass” on the preliminary exam in Accounting.

Both MS degrees require that students be in good academic standing; to have completed the minimum required coursework with a cumulative 3.0 GPA; and to have achieved a minimum of a “master’s pass” on the preliminary (“field”) exam.

**PhD**

**Total Units Required: 18**

Students in the PhD program are required to take 18 courses or a minimum of 3 courses in fall, winter, and spring quarters during years one and two. Required courses for the degree are listed below:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCT 540-1</td>
<td>Empirical Research in Accounting I (taken in years one and two)</td>
</tr>
<tr>
<td>ACCT 540-2</td>
<td>Empirical Research in Accounting II (taken in years one and two)</td>
</tr>
<tr>
<td>ACCT 550-1</td>
<td>Research in Accounting Theory I</td>
</tr>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-2</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-3</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 480-1</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 480-2</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 480-3</td>
<td>Econometrics</td>
</tr>
</tbody>
</table>

To fulfill the 18-course requirement for the PhD degree, students must take at least 7 approved electives (ACCT 499-0 Independent Study qualifies), in addition to the 11 required courses listed above. Students must maintain a minimum overall GPA of 3.0 to be in good academic standing.

**Other PhD Degree Requirements**

- Examinations: PhD qualifying exams must be completed by the end of the first and second year. Each exam is based on the accounting PhD courses taken at the end of each year.
- Research/Projects: Oral presentation of a research paper by September 15 in the first and second year, at which time the performance on the qualifying exams, coursework, and second-year paper are reviewed and students are passed into candidacy.
- PhD Dissertation: Original and significant research. Topic and advisor or advisors should be selected by the end of fall quarter of the third year; presentation of preliminary results (prospectus) to their committee no later than winter quarter of year four.
- Final Evaluations: Oral final examination on dissertation and submission of an approved dissertation.

**Acting**

https://acting.northwestern.edu/

Degree types: MFA

The Northwestern MFA in Acting offers comprehensive training in acting technique to advanced students while offering a historical context for the work of theatre and an understanding of the role and responsibilities of theatre artists in society. The training focuses on mastery, comprehension and practice of the craft of acting, with a focus on body awareness, theatre history and performance. Through the MFA in Acting program’s culture of evaluative critique, a dramaturgical approach to texts in preparation for rehearsal and collaborative classes, research seminars, and critical self-evaluation, students develop an ability to think critically and communicate clearly about acting as an art form.

The MFA in Acting provides students with the skills to expertly stage theatrical storytelling and be active collaborators throughout the process of theatrical production. It offers an intensive and in-depth curriculum in acting while also giving students access to Northwestern’s liberal arts environment. In addition, it also actively engages Chicago’s professional theatre community, one of the most vibrant centers for theatre-making in the world.

**Degrees Offered**

- Acting MFA (p. 27)

**Acting MFA**

**Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in *The Graduate School Policy Guide* (p. 7).

**Master’s**

**Total Units Required: 30**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
</tr>
<tr>
<td>Acting I</td>
<td></td>
</tr>
<tr>
<td>Movement I</td>
<td></td>
</tr>
</tbody>
</table>
African American Studies

https://www.afam.northwestern.edu/

Degree Types: PhD

African American Studies by its very nature is an interdisciplinary field. It acquaints students with myriad ways of thinking, researching, and writing about the diverse experiences of African Americans in the United States and of African descended people throughout the African Diaspora (from dispersion, colonialism, the slave trade and slavery, through emancipation, decolonization, independence, and postcolonialism). African American Studies brings together the voluminous scholarship generated by past and present historians; political scientists; sociologists; cultural, literary, and performance studies critics; and scholars working on diverse topics and constructions of class, race, ethnicity, gender, and sexuality.

The Department of African American Studies is comprised of renowned core faculty and faculty affiliates who are integrally involved in the teaching, service, and research interests of the department. Affiliated faculty members are invited, and in fact expected, to be key participants in African American Studies. Both our core and affiliated faculty have appointments in the following Northwestern University schools: Weinberg College of Arts and Sciences, School of Communication, Human Development and Social Policy, Medill, the Henry and Leigh Bienen School of Music, and the Garrett-Evangelical Theological Seminary. This involvement of affiliates positions us well to mobilize their active support and engagement for the graduate program in African American Studies. Affiliated faculty stand poised to assist with graduate teaching by cross-listing their current graduate course offerings; serving on the examination and dissertation committees of our students; and participating on administrative committees related to the graduate program such as in-house competitive fellowships, admissions, and program governance.

The Department offers advanced graduate training through a PhD in African American Studies. Three substantive areas form the basis of this program:

1. Expressive Arts, Literature, and Cultural Studies
2. Politics, Society, and Culture
3. History

Each of these areas is populated by scholars within the department who focus their research within a domestic and/or international context. The PhD program in African American Studies provides students with the historical background in the experiences of people of African descent, the analytic preparation to carry out rigorous empirical and theoretical research, and the professional development to pursue careers in academia or beyond.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Cluster Initiative program. For more information on how
you can have a second intellectual “home” outside of your department or program, please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificate).

**Degrees Offered**
- African American Studies PhD (p. 29)

## African American Studies PhD

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

Students entering the African American Studies doctoral program are eligible for a Master of Arts degree when they complete the program’s 18-course requirement and a Second Year Paper that has been approved by the Graduate Committee. Students must have a minimum GPA of 3.0 in the required 18 courses to be eligible for the master’s degree. Up to 6 courses can be transferred from other graduate institutions to count towards the 18-course degree requirement. To obtain a master’s degree, students should submit the Application for Degree and a Master’s Degree Completion form via TGS Forms in CAESAR by the published deadlines for degree awarding for a given quarter. Students must complete all the requirements for the master’s degree within five years of the date of their initial registration in The Graduate School.

**PhD**

**Total Units Required: 18**

The track is one of the three areas of research training in the Department of African American Studies:

1. History
2. Expressive Arts, Literature, and Cultural Studies

The program offers a graduate curriculum that provides a range of graduate students with a firm grounding in a variety of essential texts, materials, methodologies, and traditions. We believe that graduate students in departments addressing social inequality, race, gender, sexuality, political movements, culture, and migration, among other topics, will benefit from taking classes in our graduate program (and be able to satisfy some of their course requirements). At the same time, we have built in a degree of flexibility that enables our students to achieve a higher degree of proficiency within a specific sub-field. Consequently, we require all our students to take eighteen (18) courses total over two years (an average of three courses per quarter). The specific breakdown of the 18 required courses goes as follows:

- 6 core courses
- 4 track courses
- 4 courses within one’s chosen discipline of specialization
- 3 elective courses
- 1 research methods course

## Anthropology

[https://www.anthropology.northwestern.edu/](https://www.anthropology.northwestern.edu/)

**Degree Types: PhD**

The Graduate Program in Anthropology (https://www.anthropology.northwestern.edu/graduate) fosters the historic diversity of the discipline by building an intellectual dialogue between different humanistic and scientific approaches. Our research and graduate training program emphasizes the integration of the major anthropological subfields, including Archaeology, Biological Anthropology, Cultural Anthropology, and Linguistic Anthropology. We train graduate students to harness these strengths in basic research, in effective teaching, and in the application of anthropology both inside and outside of academia.

Current strengths of graduate training include the areas of political economy, gender, sexuality and race, social class, life course, material culture, health/medical anthropology, reproductive ecology, urban anthropology, human biology, prehistoric complex societies, and historical archaeology. Faculty specialize in a range of world areas, including North and South America, Africa, and the Middle East and North Africa.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Cluster Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program, please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificate).

**Degrees Offered**
- Anthropology PhD (p. 29)
- Medical Anthropology PhD/MPH (p. 86)

## Anthropology PhD

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

The Department of Anthropology is devoted to the preparation of professional anthropologists. Normally, only students who intend to pursue the PhD are accepted into the program. The MA in Anthropology is an intermediate degree granted upon application to students who fulfill second-year department requirements.

**Coursework Requirements**

- See PhD Degree Requirements below.
- Total Required Units: (variable, depending upon subdiscipline)

**Other MA Degree Requirements**

- Examinations: none specified
- Research/Projects: second-year qualifying paper
- Master’s Thesis: see Research/Projects above
- Other: none

**PhD**

**Total Units Required: the total varies by subfield**

**Course Requirements:** The Department of Anthropology’s core requirements for all PhD students include:
1. the four-quarter sequence of ANTHRO 401, “The Logic of Inquiry in Anthropology,”
2. the ANTHRO 496-0 Bridging Seminar (a topically focused, advanced course designed to integrate at least two of the four subfields);
3. a subfield specific methods course.

Subfield Course Requirements

Cultural Anthropology students: In addition to the above core requirements, cultural students are required to take (489) Ethnographic Methods along with three additional courses from a “cafeteria” list approved by the cultural/linguistic faculty. The list of approved courses is distributed by the DGS at the beginning of each year. A complete list of approved courses is available from the Graduate Student Advisor.

Linguistic Anthropology students: In addition to the above core requirements, Linguistic Anthropology students are required to take two advanced graduate seminars in Linguistic Anthropology (ANTHRO 484-0 Seminar in Linguistic Anthropology), one course in methods in Linguistic Anthropology (ANTHRO 361-0 Talk as Social Action) and at least one, and preferably two or more, from a “cafeteria” list of courses approved by the cultural/linguistic faculty.

Archaeology students: In addition to the above core requirements, archaeology students are required to take seven subfield requirements: two graduate level courses in biological, cultural or linguistic anthropology, ANTHRO 322-0 Introduction to Archaeology Research Design & Methods and two graduate level Topics courses (ANTHRO 490-0 Topics in Anthropology). All students must also demonstrate knowledge and field and laboratory methods.

Biological Anthropology students: In addition to the above core requirements, biological anthropology students are required to take ANTHRO 386-0 Methods in Human Biology Research, “Human Population Biology” (ANTHRO 490-0 Topics in Anthropology), and ANTHRO 486-0 Evolution & Biological Anthropology. Biological students are also required to take at least one (and preferably) two quarters of statistics, which can be fulfilled through the Anthropology Department or elsewhere (e.g., Sociology, public health, SESP).

Required Papers and Proposals
Students are required to complete a Second Year Qualifying Paper, a Dissertation Proposal, and a Dissertation.

Applied Physics

https://www.appliedphysics.northwestern.edu/

Degree Types: PhD

The Applied Physics Graduate Program (https://www.appliedphysics.northwestern.edu/) is a joint program between the McCormick School of Engineering & Applied Science and the Weinberg College of Arts & Sciences, and spans the departments of Physics & Astronomy, Biomedical Engineering, Chemistry, Earth & Planetary Sciences, Electrical & Computer Engineering, Computer Science, and Materials Science & Engineering. The program offers interdisciplinary PhD research opportunities for graduate students with a strong undergraduate background in Physics.

The Applied Physics Program is designed to allow students to complete their PhD studies in as little as five years. Students can complete the required courses during the first year, allowing them to fully focus their efforts on research starting as of the second year. Unlike programs based in a single department, Applied Physics students can take advantage of the scholarships, learning opportunities, and other resources offered by both the McCormick School of Engineering, the Weinberg College of Arts & Sciences, and nearby Argonne National Laboratory and Fermi National Accelerator Laboratory.

The program prepares graduates for professional careers in science and technology, either in academics or in industry, and seeks to ensure that our graduates recognize and take advantage of scientific and technological opportunities wherever they may arise.

Degrees Offered

- Applied Physics PhD (p. 30)

Applied Physics PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

The Applied Physics Program does not offer a terminal master’s program, and only students who intend to pursue the PhD are admitted. However, PhD students who satisfactorily complete the first year of classes and pass a comprehensive examination are eligible to receive a Master of Science degree.

PhD

The formal requirements for a PhD in Applied Physics are:

- The core courses
- The oral qualifying exam
- The teaching experience
- The prospectus or thesis proposal
- The thesis defense

Core Courses

Total Units Required: 10

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT_SCI 401-0 or PHYSICS 416-0</td>
<td>Chemical &amp; Statistical Thermodynamics of Materials</td>
</tr>
<tr>
<td>PHYSICS 412-1 &amp; PHYSICS 412-2</td>
<td>Quantum Mechanics</td>
</tr>
<tr>
<td>PHYSICS 411-1 or CHEM 519-0</td>
<td>Methods of Theoretical Physics</td>
</tr>
<tr>
<td>GEN_ENG 519-0 or PHYSICS 519-0</td>
<td>Responsible Conduct for Research Training (required but not for credit)</td>
</tr>
<tr>
<td>PHYSICS 414-1</td>
<td>Electrodynamics</td>
</tr>
<tr>
<td>MAT_SCI 405-0 or PHYSICS 422-1</td>
<td>Physics of Solids or Condensed-Matter Physics</td>
</tr>
<tr>
<td>Computational Methods of Applied Physics course</td>
<td>See list of course options below.</td>
</tr>
<tr>
<td>Experimental Methods of Applied Physics course</td>
<td>See list of course options below.</td>
</tr>
<tr>
<td>Elective 1 (Graduate level class)</td>
<td></td>
</tr>
<tr>
<td>Elective 2 (Graduate level class)</td>
<td></td>
</tr>
</tbody>
</table>
## List of course options for Computational Methods of Applied Physics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 448-0</td>
<td>Computational Chemistry</td>
</tr>
<tr>
<td>CHEM_ENG 451-0</td>
<td>Applied Molecular Modeling</td>
</tr>
<tr>
<td>ES_APPM 446-2</td>
<td>Numerical Solution of Partial Differential Equations</td>
</tr>
<tr>
<td>MAT_SCI 458-0</td>
<td>Atomic Scale Computational Materials Science</td>
</tr>
<tr>
<td>MECH_ENG 417-0</td>
<td>Multi-scale Modeling and Simulation in Solid Mechanics</td>
</tr>
<tr>
<td>MECH_ENG 418-0</td>
<td>Multi-Scale Modeling and Simulation in Fluid Mechanics</td>
</tr>
<tr>
<td>MECH_ENG 423-0</td>
<td>Intro to Computational Fluid Dynamics</td>
</tr>
<tr>
<td>MECH_ENG 426-1</td>
<td>Advanced Finite Element Methods I</td>
</tr>
<tr>
<td>MECH_ENG 426-2</td>
<td>Advanced Finite Element Methods II</td>
</tr>
<tr>
<td>PHYSICS 430-0</td>
<td>Nonlinear Dynamics &amp; Chaos</td>
</tr>
<tr>
<td>ELEC_ENG 495-0</td>
<td>Special Topics in Electrical Engineering</td>
</tr>
<tr>
<td>ELEC_ENG 475-0</td>
<td>Machine Learning: Foundations, Applications, and Algorithms</td>
</tr>
<tr>
<td>ELEC_ENG 463-0</td>
<td>Adaptive Filters</td>
</tr>
</tbody>
</table>

There are different classes listed under 495-0 - Approval is for Optimization techniques for machine learning and deep learning and for Deep learning from scratch.

## List of course options for Experimental Methods of Applied Physics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH_ENG 433-0</td>
<td>Advanced Mechatronics</td>
</tr>
<tr>
<td>MAT_SCI 460-0</td>
<td>Electron Microscopy</td>
</tr>
<tr>
<td>MAT_SCI 461-0</td>
<td>Diffraction Methods in Material Science</td>
</tr>
<tr>
<td>MAT_SCI 465-0</td>
<td>Advanced Electron Microscopy &amp; Diffraction</td>
</tr>
<tr>
<td>MAT_SCI 466-0</td>
<td>Analytical Electron Microscopy</td>
</tr>
</tbody>
</table>

## Oral Qualifying Exam

Students are required to pass a qualifying exam before advancing to the second year of the program. This exam takes the form of a short presentation made to an examining committee, followed by a closed question session before the committee. There is no written qualifier.

## Teaching Experience

One quarter of teaching experience is required by the Graduate School. Since AP is a graduate-only program, our students gain this experience by serving as TAs in a variety of undergraduate departments.

## Prospectus or Thesis Proposal and Defense

Students must submit and defend their thesis proposal before the end of the spring quarter of the third year. This includes a written proposal and a 30 mins defense followed by questions from the faculty committee.

## Thesis Defense

Each PhD candidate must pass a Thesis Defense based on the work presented in the candidate's dissertation. The faculty committee assembled previously for the thesis proposal and defense conducts the examination. The examination involves a mandatory open and publicized oral presentation and discussion during the first hour, followed by a closed examination with only the faculty committee. A conference room should be reserved for three hours by the candidate.

## Art History

https://www.arthistory.northwestern.edu/

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Degree Types: PhD

The Department of Art History (https://www.arthistory.northwestern.edu) offers a full-time doctoral program that is designed to prepare our graduates for academic research and teaching, work in museums, and other careers in the visual arts. Coursework is for students with a solid undergraduate grounding in the field, and moves from a general, conceptual survey of the discipline to a more specific exploration of the student’s chosen field. Graduates are primarily trained for teaching careers, but many alumni have had considerable success in the museum field.

The faculty is renowned for its interdisciplinary scholarship with particular strengths in Black Visual Culture in the United States and African Diaspora, Modern and Contemporary art and architecture across the globe, early modern and 19th-century European art and architecture, and Buddhist art.

The department's comparative and transdisciplinary orientation offers ample opportunity for innovative research, which is amplified by programs and clusters across the Weinberg College of Arts and Sciences (WCAS) and within The Graduate School (TGS). Students in this program are encouraged to participate in TGS’s Interdisciplinary initiative program (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certiﬁcates).

Our highly ranked program is designed to make the most of our local resources, from courses at neighboring universities to holdings in Chicagoland libraries including the Newberry and Ryerson Libraries. The recently established Chicago Objects Study Initiative, funded by the Andrew W. Mellon Foundation, brings together scholars from Northwestern, the University of Chicago, and the Art Institute of Chicago (AIC) via shared programming that includes first-year graduate student coursework, internships and fellowships, and symposia open to a wider Chicago audience. Graduate students also garner experience working within departments at other local museums, including the Museum of Contemporary Art Chicago and Northwestern's own Mary & Leigh Block Museum of Art.

## Degrees Offered

- Art History PhD (p. 31)

## Art History PhD

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

## Master’s

There is no terminal MA in the Department of Art History. The MA is awarded to all students who successfully complete the 1st and 2nd year requirements in good standing and apply for the degree with The Graduate School. All students entering the program, whether with or without a master's degree from another institution, are required to complete the qualifying paper at the end of their second year to verify their readiness to complete major and minor doctoral field requirements.

## PhD

Students are expected to take courses with a wide range of faculty members. Students must take 8 courses the primary field, and 4 courses in 3 major fields other than the student's own major field. 300-level
Total Required Graded Courses: 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART_HIST 401-1</td>
<td>Methods and Historiography of Art History</td>
</tr>
<tr>
<td>ART_HIST 405-0</td>
<td>Art Historical Research (Summer Seminar Abroad)</td>
</tr>
<tr>
<td></td>
<td>Other courses in primary field and to fulfill breadth requirements (8 units)</td>
</tr>
<tr>
<td>ART_HIST 402-0</td>
<td>Studies in Representation (Writing Seminar)</td>
</tr>
<tr>
<td>ART_HIST 499-0</td>
<td>Independent Study (no more than 1 per quarter; preference to courses in primary field and to fulfill breadth requirements)</td>
</tr>
<tr>
<td>ART_HIST 570-0</td>
<td>Teaching Assistantship in Art History (optional, up to 3 units; can be taken in 2nd year, up to 2 in the 3rd year, but no more than 1 allowed per quarter)</td>
</tr>
<tr>
<td>ART_HIST 406-0</td>
<td>Dissertation Proposal Writing (Prospectus)</td>
</tr>
</tbody>
</table>

Other PhD Degree Requirements

- **Examinations, Language:** Students must demonstrate proficiency in two foreign languages before being advanced to candidacy. One of these must be completed by spring quarter in the 1st year; the second by the end of the 3rd year. Typically, one of these languages is either French or German. The second language is selected by the student and advisor in relations to the student’s plan of study. In some circumstances, additional language competency may be required. Please see the Department of Art History Graduate Handbook (https://www.arthistory.northwestern.edu/graduate/resources) for more information.

- **Review, Holistic 2nd Year Review:** In early fall of the 2nd year, no later than October 15, students meet with committee consisting of the advisor and a second faculty member from a different field. In advance of the meeting, the student will update the Academic Progress section on GSTS and submit to the committee a seminar paper from their 1st year that they feel represents their best art history work to date. These materials, along with seminar reports from the student’s 1st year, are discussed, along with a proposed topic for the PhD qualifying paper. More information about this review can be found in the Department of Art History Graduate Handbook (https://www.arthistory.northwestern.edu/graduate/resources).

- **Paper, Qualifying:** At the end of the winter quarter of the 2nd year, at a date set by the instructor of ART_HIST 402-0 Studies in Representation (Writing Seminar), students are required to submit a PhD qualifying paper. This paper must demonstrate an advanced level of art historical research, rigorous analysis, convincing argumentation, clear organization, and mastery of the discipline’s (or subfield’s) conventions of citation and illustration.

- **Examinations, Oral Qualifying:** In the winter quarter of the 3rd year, all students take a three-hour oral PhD qualifying exam. The exam is administered by a three-person committee chosen by the student in consultation with the advisor and is based on field bibliographies generated in consultation with the advisor and appropriate committee members by the fall quarter of the 3rd year.

- **Paper, Dissertation Prospectus:** After passing the oral PhD qualifying exam, students write an 8-10 page dissertation prospectus (plus bibliography) in the spring of the 3rd year. This is written in close consultation with the advisor and refined in ART_HIST 406-0 Dissertation Proposal Writing (Prospectus Seminar). It is meant to present a clear vision of the student’s project, the objects/issues on which it focuses, and the contribution it stands to make to the field.

- **Paper, 5th Year Chapter:** Before the end of the spring quarter of the 5th year, a candidate is expected to have completed an acceptable draft of at least one chapter of the dissertation. Candidates should submit a copy to their primary advisors and committee members. The chapter need not be “defended” in a meeting with the committee, nor is it awarded a pass/not pass grade, but is vetted by the committee who provide feedback to the candidate within a reasonable amount of time, no more than one month after submission.

- **PhD Dissertation:** Dissertation supervised by at least three-person faculty committee and defended at an oral defense with the committee.

- **Other:** teaching assignments; written evaluations of student’s performance in each course at end of each quarter (seminar reports); review of seminar reports by faculty at beginning of each quarter; students with deficient evaluations meet with department chair and advisor; copies of seminar reports distributed to students. On the basis of cumulative written negative evaluations, students in serious difficulty at end of the 1st or 2nd year may not be permitted to continue in the program. Students must select an advisor by the last day of exam week in spring quarter of their 1st year and their committee by the second week of the fall quarter of their 3rd year.

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### Art Theory and Practice

https://art.northwestern.edu/

**Degree Types:** MFA

The Art Theory and Practice two-year graduate program is best suited to students looking to pursue intense and prolonged periods of studio work in addition to academic study. The program’s small size, averaging 10 students, ensures a continuous intensive exchange among faculty and graduate students resulting in a rigorous critical atmosphere in which a range of theoretical perspectives and diverse ways of making and talking about art are valued and encouraged. The backbone of the program is independent study with the core graduate faculty. The periodic addition of visiting lecturers supplements the faculty, adding further dimension and depth.

Complimenting this are seminars, group critique courses and electives. Furthermore, every other year the department funds a graduate student study trip. Our program is geared to not only equip our graduates for professional careers as artists and college-level teachers, but to place them on the very forefront of contemporary cultural production.

While our emphasis is on the development of individual studio practice, the program encourages parallel intellectual development in critical theory, art history and non-department electives.

Applicants should contact the program or visit the Art Theory and Practice website (https://art.northwestern.edu) to learn about program details and program-specific requirements for admission.
Degrees Offered
• Art Theory and Practice MFA (p. 33)

Art Theory and Practice MFA
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s
Total Units Required: 18

Course Title
At least 5 and not more than 6 units of ART 499-0
ART 423-0 Visual Artist’s Writing Practicum

Students are required to enroll in this course during their second year, but may take the class for credit during their first year as well.

5 300 or 400-level courses in department
Possible courses: ART 372-0, ART 382-0, ART 422-1, ART 423-0, ART 425-0 (these courses may each be taken multiple times for credit)

4 art history, theory, or criticism courses

2 of which must be ART 372-0 or ART 382-0, and 2 may be courses approved for graduate-level credit in other departments

At least 2 and not more than 3 electives

Other MFA Degree Requirements
• Critiques: At the end of each quarter, each student’s work is discussed and evaluated by the entire faculty and visiting experts.
• Final Evaluations: Students must mount a thesis exhibition, and defend their final thesis in front of a committee of graduate faculty.

Astronomy

https://www.physics.northwestern.edu/

Degree Types: PhD

The Northwestern Astronomy PhD (https://www.physics.northwestern.edu/graduate/doctoral-program/astronomy-phd-degree-requirement.html) is designed to provide students with a broad training in astronomy while enabling them to get started quickly with their graduate research. The Astronomy PhD is a flexible program that allows students to complement their astronomy training with a selection of physics courses or courses from other quantitative disciplines such as applied mathematics, statistics, computer science or engineering relevant to their research.

Students pursuing astronomy or astrophysics research in our department will benefit from the vibrant environment and opportunities offered by the Center for Interdisciplinary Research and Exploration in Astrophysics (https://ciera.northwestern.edu) (CIERA).

Degrees Offered
• Astronomy PhD (p. 33)

Astronomy PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: 12

Course Title
Required Course
PHYSICS 411-0 Classical Mechanics

A minimum of six 400-level astronomy courses selected from the following:
ASTRON 410-0 Astrophysical Radiative Processes and Transport
ASTRON 414-0 Planetary Astrophysics
ASTRON 416-0 Astrophysical Fluid Dynamics
ASTRON 421-0 Observational Astrophysics
ASTRON 425-0 Stellar Astrophysics
ASTRON 429-0 Extragalactic Astrophysics and Cosmology
ASTRON 448-0 Interstellar Matter and Star Formation
ASTRON 449-0 Stellar Dynamics
ASTRON 451-0 High Energy Astrophysics

A minimum of two 400-level physics courses, of which Physics 411-0 counts as one

A minimum of four other 400-level quantitative science or engineering courses (including in physics or astronomy)

Other PhD Degree Requirements
• Examinations: Students who do not maintain a B (3.0) average in their core first-year courses will be required to sit for an oral qualifying examination.
• PhD Dissertation

MS Degree Requirements for PhD Students
Students enrolled in the Ph.D. program have the opportunity to obtain a formal master’s degree as they work toward completion of the Ph.D. These requirements are as follows:
• Completion of 12 graded courses as described above
• GPA of 3.0 or higher

Biomedical Engineering

http://www.mccormick.northwestern.edu/biomedical

Degree Types: MS, PhD

The Biomedical Engineering Graduate Program (https://www.mccormick.northwestern.edu/biomedical/graduate) centers on engineering methods for studying biological and physiological processes and the application of concepts to medical problems.

Research areas include Biomaterials and Regenerative Engineering (https://www.mccormick.northwestern.edu/biomedical/research/areas/biomaterials-and-regenerative-engineering.html), Imaging and Biophotonics (http://www.mccormick.northwestern.edu/biomedical/research/areas/imaging-biophotonics.html), and Neural Engineering (https://www.mccormick.northwestern.edu/biomedical/research/areas/neural-engineering.html). Graduate study in biomedical engineering is conducted in the Robert R. McCormick School of Engineering and Applied
Science, The Feinberg School of Medicine, and The Shirley Ryan Ability Lab.

The MS-only program is designed to produce graduates who are qualified to fill positions in research and development or pursue further education. Graduates may expect to seek employment on the research staffs of engineering schools, medical schools, hospitals, industrial firms, and government laboratories.

We have three different Master’s programs all of which lead to an MS (switching between these programs, once started, requires approval of the Director of the MS Program):

1. Master’s degree without thesis
2. Master’s degree with thesis
3. A combined BS/MS program with or without Master’s thesis

Completion of the Master’s degree program may take as little as three quarters, if done without a thesis. With a thesis, a typical time for completion would be two years.

The PhD program provides a solid foundation in engineering and life sciences. It is designed to produce graduates who can lead research and development programs at the highest levels in industry, academia, and national laboratories.

Degrees Offered
- Biomedical Engineering BS/MS (p. 34)
- Biomedical Engineering MS (p. 34)
- Biomedical Engineering PhD (p. 35)

Biomedical Engineering BS/MS

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

BS/MS

BS/MS Degree without Thesis
- These requirements are the same as “MS-Only without Thesis”. BS/MS students will take two advanced life science courses instead of the two advanced systems physiology courses.

BS/MS Degree with Thesis
- These requirements are the same as the “MS-Only with Thesis” unless the student participates in an accelerated, thesis-based program for outstanding undergraduates who have established research relationships with BME faculty members as outlined below. BS/MS students will take two advanced life science courses instead of the two advanced systems physiology courses.

Accelerated BS/MS Degree with Thesis
Admission Requirements (no exceptions):
- 3.5 grade point average or higher in undergraduate studies
- Have conducted at least two quarters of undergraduate research (399 or paid research) with chosen advisor
- Approval by Director of the MS Program

Total Units Required: 9

Biomedical Engineering MS

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

MS-Only Degree without Thesis
Total Units Required: 12

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree Requirements</td>
<td></td>
</tr>
<tr>
<td>Research for Credit</td>
<td>BMD_ENG 499-0 Projects</td>
</tr>
<tr>
<td>Quantitative science</td>
<td>BMD_ENG 380-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>and engineering</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>courses from approved</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>list or by permission</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>(3 units)</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>Advanced statistics</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>course from approved</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>list or by permission</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>(1 unit)</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>Engineering and sciences courses</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>(1 unit)</td>
<td>BMD_ENG 499-0 Advanced Systems Physiology</td>
</tr>
<tr>
<td>Restricted electives</td>
<td>BMD_ENG 512-0 Graduate Research Seminar in Biomedical Engineering</td>
</tr>
<tr>
<td>(1 unit)</td>
<td></td>
</tr>
<tr>
<td>Graduate Seminar</td>
<td>BMD_ENG 512-0 Graduate Research Seminar in Biomedical Engineering</td>
</tr>
<tr>
<td>(3 quarters - 0 units)</td>
<td></td>
</tr>
</tbody>
</table>

1 Courses in the following areas may not count: research for credit (BMD_ENG 499-0 Projects), global health (except BMD_ENG 380-0 Medical Devices, Disease & Global Health), business, design, NUVention (except for 1 quarter of NUVention Medical), seminar, or survey courses.

2 Students may take design, global health, and business classes to fulfill this category. Students taking a basic statistics course may count it towards this category. Students may opt to take additional math/science/engineering courses to fulfill this category as well.

Other Requirements
- Examinations: defend Master’s thesis
- Research/Projects: see Master’s thesis
- Master’s Thesis: required

Biomedical Engineering MS

Other Requirements

1. Students who have taken similar physiology courses may petition to take advanced life sciences courses as replacements.
2. Courses in the following areas may not count: research for credit (BMD_ENG 499-0 Projects), global health (except BMD_ENG 380-0 Medical Devices, Disease & Global Health), business, design, NUVention (except for 1 quarter of NUVention Medical), seminar, or survey courses.
Students may take design, global health, and business classes to fulfill this category. Students taking a basic statistics course may count it towards this category. Students may opt to take additional math/science/engineering courses to fulfill this category as well.

Other Requirements
- Examinations: none specified
- Research/Projects: either (1) approved project (one quarter minimum of BMD_ENG 499-0 Projects) or (2) three courses with significant project components from approved list
- Other: 7 of the 12 courses must be engineering courses. Restricted electives courses do not count as engineering courses.

MS-Only Degree with Thesis
Total Units Required: 9

Course | Title
--- | ---
BMD_ENG 401-0 | Advanced Systems Physiology
BMD_ENG 402-0 | Advanced Systems Physiology
BMD_ENG 403-0 | Advanced Systems Physiology

Quantitative science and engineering courses from approved list or by permission (3 units)
Advanced statistics course from approved list or by permission (1 unit)
Other engineering and sciences courses (2 units)
Restricted Elective (1 unit)
Research Seminar (3 quarters - 0 units):

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD_ENG 512-0</td>
<td>Graduate Research Seminar in Biomedical Engineering</td>
</tr>
</tbody>
</table>

1 Students who have taken similar physiology courses may petition to take advanced life sciences courses as replacements.

2 Courses in the following areas may not count: research for credit (BMD_ENG 499-0 Projects), global health (except BMD_ENG 380-0 Medical Devices, Disease & Global Health), business, design, NUvention (except for 1 quarter of NUvention Medical), seminar, or survey courses.

3 Students may take design, global health, and business classes to fulfill this category. Students taking a basic statistics course may count it towards this category. Students may opt to take additional math/science/engineering courses to fulfill this category as well.

Other Requirements
- Examinations: defend master’s thesis
- Research/Projects: see master’s thesis
- Master’s Thesis: required
- Other: 5 out of 9 courses must be engineering. Restricted elective courses do not typically count as engineering courses.

Biomedical Engineering PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required:

Students entering with a BS degree: 12
Students entering with an MS degree: 9
Students enrolled in the DPT/PhD program: 9
Students enrolled in the MSTP program: 6

Students in the PhD program enter into one of 6 “tracks” representing the broad research areas in our department. The purpose of these tracks is to guide students in their course selection, providing depth in areas relevant to their selected research area. The current tracks offered are:

- Biomaterials
- Imaging and Biophotonics
- Mechanics and Transport
- Neural Engineering
- Rehabilitation
- Regenerative Medicine and Engineering

Course Requirements
Students entering with a BS degree must complete a minimum of 12 courses at Northwestern University. These are to include the required courses listed below, as well as sufficient additional coursework to meet the described competencies for the selected course track. All additional courses must be in Engineering, Science or Math. Students are to work with their primary BME adviser to ensure that the plan of study is sufficient for meeting all specified competencies. All courses used to meet these minimum requirements must be for a letter grade (i.e. P/N courses are not accepted) and none can be a 499 (research credit).

The requirements for students entering with an MS degree or students in the MSTP or PhD/DPT programs are identical to those for students entering with a BS, with the following exceptions. Note that these students must also demonstrate competency in all areas of the selected course track.

- Students entering with an MS or in the PhD/DPT programs:
  - A minimum of nine 300 or 400-level graduate courses must be taken for a letter grade (i.e. P/N courses are not accepted). One of these may be a 499 (research credit). All of these courses must be science, engineering or mathematics courses.
- Students in the MSTP:
  - A total of at least six 300 or 400-level graduate courses for a letter grade (i.e. P/N courses are not accepted). None of these may be a 499 (research credit). All of these courses must be science, engineering or mathematics courses.

The following courses are required for all students in the PhD program:

- BMD_ENG 495-0 Special Advanced Topics in Biomedical Engineering (Experimental Design and Measurement for Biomedical Engineering Graduate Students)
- All first-year students are required to complete BMD_ENG 512-0 Graduate Research Seminar in Biomedical Engineering in the fall, winter, and spring quarters. Upon petition to the Graduate Program Chair, a student may delay completion of BMD_ENG 512-0 until a subsequent time if the student is enrolled in a class that meets in conflict with BMD_ENG 512-0. This requirement does not earn course credit.
- All first-year students are required to complete GEN_ENG 519-0 Responsible Conduct for Research Training. This requirement does not earn course credit.
Additional course requirements are specified for each track below:

### Course
### Title

#### Biomedical Engineering Course Track

Students are required to complete the courses below as a part of the course component of the qualifying exam:

- BMD_ENG 343-0 Biomaterials and Medical Devices
- MECH_ENG 422-0 Statistical Mechanics for Applications

#### Imaging and Biophotonics Course Track

Students are required to take two (2) of the following courses, specific to their concentration, as a part of the course component of the qualifying exam:

- **MRI Concentration**
  - BMD_ENG 327-0 Magnetic Resonance Imaging
  - BMD_ENG 495-0 Special Advanced Topics in Biomedical Engineering (Modeling of Medical Images)

- **Biophotonics Concentration**
  - BMD_ENG 333-0 Modern Optical Microscopy & Imaging
  - BMD_ENG 429-0 Advanced Physical and Applied Optics
  - PHYSICS 357-0 Optics Laboratory

Students are also required to take at least one (1) of the following courses:

- ELEC_ENG 302-0 Probabilistic Systems
- ELEC_ENG 332-0 Introduction to Computer Vision
- ELEC_ENG 420-0 Digital Image Processing

#### Mechanics and Transport Course Track

Students are required to complete the courses below as a part of the course component of the qualifying exam:

- BMD_ENG 371-0 Mechanics of Biological Tissue
- BMD_ENG 478-0 Transport Fundamentals

#### Neural Engineering Course Track

Students are required to take two (2) of the following courses as a part of the course component of the qualifying exam:

- BMD_ENG 461-0 Neural Engineering: Computational Neuromechanics and Neuroethology
- BMD_ENG 462-0 Neural Engineering: Sensory Acquisition through Movement
- BMD_ENG 463-0 Neuropathophysiology
- BMD_ENG 469-0 Neural Control and Mechanics of Movement

Students are also required to take at least one (1) of the following courses:

- ES_APPM 370-1 Introduction to Computational Neuroscience
- COMP_SCI 349-0 Machine Learning
- ELEC_ENG 435-0 Deep Learning: FAA

400 level Electrical Engineering or Computer Science course relevant to Machine Learning

#### Regenerative Medicine and Engineering Course Track

Students are required to take two (2) of the following courses as a part of the course component of the qualifying exam:

- BMD_ENG 346-0 Tissue Engineering
- BMD_ENG 444-0 Organic Nanomaterials
- BMD_ENG 349-1 Regenerative Engineering Principles and Technologies
- MECH_ENG 422-0 Statistical Mechanics for Applications

or BMD_ENG 349-2 Regenerative Engineering Applications

Students are also required to take at least one (1) of the following courses:

- BMD_ENG 343-0 Biomaterials and Medical Devices
- BMD_ENG 344-0 Biological Performance of Materials
- MECH_ENG 422-0 Statistical Mechanics for Applications

#### Rehabilitation Course Track

Students are required to take one (1) of the following courses as a part of the course component of the qualifying exam:

- BMD_ENG 463-0 Neuropathophysiology
- BMD_ENG 469-0 Neural Control and Mechanics of Movement

Students are also required to take at least one (1) of the following courses:

- BMD_ENG 366-0 Biomechanics of Movement
- IEMS 315-0 Stochastic Models
- COMP_SCI 349-0 Machine Learning
- ELEC_ENG 435-0 Deep Learning: FAA

### Other PhD Degree Requirements

- **Examinations:** PhD Qualifying exams must be completed by the end of the second year of study. Prior to taking the oral examination, students must complete at least 8 courses (MSTP students must take all 6 courses), including the required physiology and mathematics courses, and the two required courses for the selected research track. In addition to the oral examination, administered by the department in June each year, students must pass the course component and the research component of the qualifying process. Students must earn at least an A- in the two required courses for the selected course track to pass the course component, or else an additional written exam is required. To complete the research component, students must present their initial research project to their PhD research committee by March 31 of their 2nd year, who evaluate their research progress on a pass/fail basis.

- **MS degree:** Students entering with a BS degree who are not enrolled in the MSTP or DPT/PhD program must complete an MS degree. Prior to taking the oral examination, students must complete the three components of the PhD qualifying exam and completion of an additional writing requirement satisfies the MS degree requirements. The writing requirement can be satisfied by submitting an original manuscript to a peer-reviewed journal or submitting a thesis to the BME department.

- **PhD Dissertation:** original, independent research

- **Final Evaluations:** oral defense of dissertation when all other requirements completed

- **Teaching Experience:** The teaching requirement is to be fulfilled by serving for at least one quarter as a full-time TA (approximate time commitment: 20 hr/week) for a BME course.

- **Publication Requirement:** All students are required to be the primary author on a peer-reviewed journal article accepted for publication prior to defending their PhD research.

### Biostatistics


Degree Types: MS
The Master of Science (MS) in Biostatistics program (https://www.feinberg.northwestern.edu/sites/cehs/our-programs/program-in-public-health/prospective-students) is a one-year program, providing graduate biostatistics training for students who intend to plan, direct and execute health research and/or analyze health data. The MS in Biostatistics program is distinguished by its concurrent emphasis on both statistical methodology and computer programming skills. It is a full-time program completed in four quarters or a half-time program completed in eight quarters. All students complete a thesis project in collaboration with biostatistics faculty and other Feinberg School of Medicine faculty researchers.

Three concentration options address a variety of student goals. The Concentration in Population Health Analytics is designed for college graduates or students with professional degrees (e.g. MD, DPT, allied health professionals) who intend to plan, direct and execute health research. The Concentration in Statistical Bioinformatics is designed for college graduates who are interested in working as statistical analysts/programmers on research teams and emphasizes cutting edge computation and analysis for genomics and other bioinformatics ‘big data’. The Concentration in Statistical Methods and Practice is designed for college graduates who are interested in working as statistical analysts/programmers on research teams and encompasses a broader range of statistical theory and methods for data from health and medical research settings.

Upon completion of the program, students will be well-qualified for positions in academic research departments or the pharmaceutical, insurance, or health care consulting industries.

### Degrees Offered
- Biostatistics MS (p. 37)

### Biostatistics MS

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

#### Master’s

##### Required Courses: All Concentrations

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPL_BIO 301-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>EPL_BIO 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>EPL_BIO 401-0</td>
<td>Intermediate Epidemiology</td>
</tr>
<tr>
<td>EPL_BIO 402-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>EPL_BIO 305-0</td>
<td>Applied Statistical Programming in SAS</td>
</tr>
<tr>
<td>EPL_BIO 306-0</td>
<td>R Programming</td>
</tr>
<tr>
<td>PUB_HLTH 441-0</td>
<td>Ethical Issues in Clinical Research</td>
</tr>
<tr>
<td>EPL_BIO 561-0</td>
<td>Thesis</td>
</tr>
</tbody>
</table>

##### Additional Required Courses and Selectives

#### Concentration in Population Health Analytics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPL_BIO 403-0</td>
<td>Statistical Inference and Applied Techniques</td>
</tr>
<tr>
<td>PUB_HLTH 446-0</td>
<td>Design, Conduct &amp; Analysis of Clinical Trials</td>
</tr>
<tr>
<td>EPL_BIO 502-0</td>
<td>Advanced Biostatistics</td>
</tr>
<tr>
<td>EPL_BIO 521-0</td>
<td>Applied Survival Data Analysis</td>
</tr>
<tr>
<td>EPL_BIO 560-0</td>
<td>Statistical Consulting</td>
</tr>
</tbody>
</table>

#### Selectives

Choose 1 credit

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_HLTH 315-0</td>
<td>Topics in Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 412-0</td>
<td>Infection Disease Epidemiology and Prevention</td>
</tr>
<tr>
<td>PUB_HLTH 524-0</td>
<td>Cardiovascular Disease Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 499-0</td>
<td>Independent Study</td>
</tr>
</tbody>
</table>

#### Concentration in Statistical Bioinformatics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPL_BIO 303-0</td>
<td>Basic Probability</td>
</tr>
<tr>
<td>EPL_BIO 403-0</td>
<td>Statistical Inference and Applied Techniques</td>
</tr>
<tr>
<td>PUB_HLTH 446-0</td>
<td>Design, Conduct &amp; Analysis of Clinical Trials</td>
</tr>
<tr>
<td>EPL_BIO 502-0</td>
<td>Advanced Biostatistics</td>
</tr>
<tr>
<td>EPL_BIO 521-0</td>
<td>Applied Survival Data Analysis</td>
</tr>
<tr>
<td>EPL_BIO 560-0</td>
<td>Statistical Consulting</td>
</tr>
</tbody>
</table>

#### Selectives

Choose 1.5 credits

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGP 485-0</td>
<td>Data Science For Biomedical Researchers</td>
</tr>
<tr>
<td>EPL_BIO 529-0</td>
<td>Statistical Genetics</td>
</tr>
<tr>
<td>HSIP 441-0</td>
<td>Health and Biomedical Informatics Methods I</td>
</tr>
<tr>
<td>HSIP 442-0</td>
<td>Biomedical Informatics Methods II</td>
</tr>
<tr>
<td>IGP 430-0</td>
<td>Genetics</td>
</tr>
<tr>
<td>PUB_HLTH 499-0</td>
<td>Independent Study</td>
</tr>
</tbody>
</table>

#### Concentration in Statistical Methods and Practice

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPL_BIO 303-0</td>
<td>Basic Probability</td>
</tr>
<tr>
<td>EPL_BIO 403-0</td>
<td>Statistical Inference and Applied Techniques</td>
</tr>
<tr>
<td>PUB_HLTH 446-0</td>
<td>Design, Conduct &amp; Analysis of Clinical Trials</td>
</tr>
<tr>
<td>EPL_BIO 502-0</td>
<td>Advanced Biostatistics</td>
</tr>
<tr>
<td>EPL_BIO 521-0</td>
<td>Applied Survival Data Analysis</td>
</tr>
<tr>
<td>EPL_BIO 560-0</td>
<td>Statistical Consulting</td>
</tr>
</tbody>
</table>

#### Electives

Some courses below are Required or Selectives for some Concentrations

<table>
<thead>
<tr>
<th>Concentration in Population Health Analytics (2.5 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration in Statistical Bioinformatics (1.5 units)</td>
</tr>
<tr>
<td>Concentration in Statistical Methods and Practice (1.5 units)</td>
</tr>
</tbody>
</table>

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**Northwestern University**
Chemistry

https://www.chemistry.northwestern.edu/

Degree Types: PhD

The Department of Chemistry (https://www.chemistry.northwestern.edu/graduate) focuses on graduate teaching and research at the forefront of the discipline, and prepares students for research positions in industry or academia.

Advanced courses, seminars, and research opportunities are offered in inorganic, organic, physical and biological chemistry. We also promote the interdisciplinary research areas of materials chemistry, environmental chemistry, and the chemistry of life processes.

Our students and faculty collaborate with campus research centers including the Materials Research Science and Engineering Center (MRSEC), the Center for Catalysis and Surface Science, the International Institute for Nanotechnology (IIN), the Argonne-Northwestern Solar Energy Research Center, Chemistry of Life Processes Institute (CLP), Center for Molecular Innovation and Drug Discovery (CMIDD), and the Center for Bio-Inspired Energy Science (CBES).

Degrees Offered

• Chemistry PhD (p. 38)

Chemistry PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

The Chemistry Department’s graduate program is designed to lead to the PhD degree, and it is expected that all students who enroll are pursuing the doctorate. However, a student leaving the Doctoral Program is eligible to receive a terminal master’s degree provided appropriate requirements delineated in the Departmental Graduate Program Guide are met.

Coursework Requirements

• Nine units of graduate-level coursework in chemistry are required.
• Research Requirements: Sufficient research to complete master’s thesis is required prior to degree completion.

PhD

Total Units Required: 9

Coursework Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 519-0</td>
<td>Responsible Conduct of Research Training</td>
</tr>
<tr>
<td>CHEM 570-0</td>
<td>Chemistry Colloquium (taken for three quarters in the first year)</td>
</tr>
</tbody>
</table>

Additional Courses

Additional course requirements differ for each major field of study.¹

¹ Each division within the chemistry program has its own set of additional course requirements. See the Graduate Program Guide (https://www.chemistry.northwestern.edu/graduate/current/timeline) for additional information.

Other PhD Degree Requirements

• Examinations: qualifying exam consisting of written document and oral examination prior to end of seven quarters of graduate study
• Original research proposal (ORP) has specific requirements in the third and fourth years of graduate study and at the dissertation defense. See the chemistry graduate program guide for further details. The ORP is not an extension of the dissertation topic.
• PhD Dissertation: must describe original research
• Final Evaluations: oral dissertation defense when all other requirements completed
• Other: all full-time students are required to teach for four quarters in their first two years of study. In order to complete the teaching requirement, all international students must comply with English proficiency requirements.

Chemical and Biological Engineering

https://www.mccormick.northwestern.edu/chemical-biological/

Degree Types: MS, PhD

Graduates of the Chemical and Biological Engineering Program (https://www.mccormick.northwestern.edu/chemical-biological/graduate) develop mastery of modern chemical and biological engineering theory and practice through a core curriculum. They gain specialized knowledge through elective courses within and outside of the department.

PhD candidates collaborate with a faculty member to develop and pursue a research program that defines and solves a problem at the frontier of chemical engineering. MS candidates are also able to pursue research with the thesis option.
Current areas of research interest by faculty in the department are organized into the broad categories of:

1. biotechnology, bioengineering, and complexity,
2. energy and sustainability, and
3. materials and nanotechnology.

**Degrees Offered**
- Chemical and Biological Engineering MS (p. 39)
- Chemical and Biological Engineering PhD (p. 39)

### Chemical and Biological Engineering MS

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master's**

**Total Units Required:** 10

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Department Core Courses (3 units)</strong></td>
<td></td>
</tr>
<tr>
<td>CHEM_ENG 421-0</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>CHEM_ENG 422-0</td>
<td>Heat and Mass Transfer</td>
</tr>
<tr>
<td>CHEM_ENG 408-0</td>
<td>Chemical Engineering Kinetics and Reactor Design</td>
</tr>
<tr>
<td>CHEM_ENG 404-0</td>
<td>Advanced Thermodynamics</td>
</tr>
<tr>
<td><strong>Electives (7 units)</strong></td>
<td></td>
</tr>
<tr>
<td>One elective must be taken within the department if thesis option is selected; three electives must be taken within the department if non-thesis option is selected.</td>
<td></td>
</tr>
</tbody>
</table>

Optional 3 unit thesis (three units of independent study projects)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM_ENG 499-0</td>
<td>Projects</td>
</tr>
</tbody>
</table>

1 For thesis master's: at least 4 courses in Chemical and Biological Engineering are required; this includes the 3 required distribution courses.

For non-thesis master's: at least 6 courses in Chemical and Biological Engineering are required; this includes the 3 required distribution courses.

**Other MS Degree Requirements**

- **Examinations:** none specified
- **Research/Projects:** none specified
- **Master's Thesis:** optional (worth three units)
- **Other:** none

### Chemical and Biological Engineering PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**PhD**

**Total Units Required:** 10

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Department Courses (6 units)</strong></td>
<td></td>
</tr>
<tr>
<td>Core chemical engineering topics (4 units):</td>
<td></td>
</tr>
<tr>
<td>CHEM_ENG 421-0</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>CHEM_ENG 422-0</td>
<td>Heat and Mass Transfer</td>
</tr>
<tr>
<td>CHEM_ENG 408-0</td>
<td>Chemical Engineering Kinetics and Reactor Design</td>
</tr>
<tr>
<td>CHEM_ENG 404-0</td>
<td>Advanced Thermodynamics</td>
</tr>
<tr>
<td><strong>Departmental electives (2 units)</strong></td>
<td></td>
</tr>
<tr>
<td>Must be chosen from outside the department (2 units)</td>
<td></td>
</tr>
<tr>
<td>May be chosen from within or outside the department (2 units)</td>
<td></td>
</tr>
</tbody>
</table>

**Other PhD Degree Requirements:**

- **Departmental Seminar:** 4 quarters of attendance of the research seminar
- **Short courses:** Responsible Conduct of Research and Professional Skills
- **Teaching:** Four quarters as a teaching assistant or a participant as a Teaching Apprentice
- **Examinations:** oral defense of dissertation research proposal during first nine quarters of residency
- **Research/Projects:** toward dissertation
- **PhD Dissertation:** based on independent, original research
- **Final Evaluations:** oral defense of dissertation

### Civil and Environmental Engineering

https://www.mccormick.northwestern.edu/civil-environmental/

**Degree Types:** PhD, MS

The Department of Civil and Environmental Engineering (https://www.mccormick.northwestern.edu/civil-environmental/graduate) offers MS and PhD degrees in environmental engineering and science, geotechnics, transportation systems analysis and planning, MS in structural engineering and a PhD degree in mechanics, materials, and structures.

Both MS and PhD degree programs provide a strong background in the theory and practice of modern civil and environmental engineering through formal course and research requirements. Each student's program is designed to suit his or her interests and previous education.

The MS program emphasizes enhancement of professional skills, knowledge, and research techniques. The PhD is a research degree involving novel, creative, and extensive approaches to problem solving.

### Degrees Offered

- Civil and Environmental Engineering MS (p. 40)
- Civil and Environmental Engineering PhD (p. 40)
Civil and Environmental Engineering MS

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's
Total Units Required: 12

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departmental courses (8 units)</td>
<td></td>
</tr>
<tr>
<td>Elective courses (approved by the Department; 4 units)</td>
<td></td>
</tr>
<tr>
<td>Program related seminar series (3 quarters, 0 units)</td>
<td></td>
</tr>
</tbody>
</table>

Other MS Degree Requirements
Additional course requirement information available on the Department website (https://www.mccormick.northwestern.edu/civil-environmental/graduate).

Civil and Environmental Engineering PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: TGS requires a minimum of nine courses to be completed for a letter grade (e.g. A, B, C, etc). Transfer credits are not allowed. Individual programs may require more than nine units. Students completing a MS degree in the same program along the way to earning a PhD may be able to use some of the MS coursework to meet the coursework requirement, depending on the guidelines of the individual program and consent of the advisor.

Programs of study for the PhD include MS requirements plus advanced engineering courses with coursework as needed in mathematics, operations research, chemistry, biology, geology, physics, materials science, economics, geography, sociology, and political science. (See department guide.)

Specializations
The Civil and Environmental Engineering PhD program has four specializations:

- Environmental engineering and science (https://www.mccormick.northwestern.edu/civil-environmental/graduate/environmental-engineering-science)
- Geotechnics (https://www.mccormick.northwestern.edu/civil-environmental/graduate/geotechnics)
- Mechanics, materials, and structures (https://www.mccormick.northwestern.edu/civil-environmental/graduate/mechanics-materials-structures)
- Transportation systems analysis and planning (https://www.mccormick.northwestern.edu/civil-environmental/graduate/transportation-systems-analysis-planning)

Other PhD Degree Requirements
- **Candidacy**: Admission to Candidacy is a milestone where faculty assess whether a student has acquired sufficient knowledge and experience to proceed with PhD research. The initial offer of admission to the PhD program does not guarantee Admission to Candidacy. In order to advance to Candidacy the student must: a) meet the TGS English Proficiency Requirement b) Identify research advisor c) achieve cumulative 3.5 GPA d) pass the Qualifying Exam.
- **Prospectus**: The Prospectus process typically involves development of a written research proposal that will culminate in the dissertation. This research proposal is presented and defended in oral form to the prospectus committee.
- **PhD Dissertation**: PhD students must complete a written dissertation that is a significant and original research contribution, based on the research proposal in the Prospectus. PhD students defend the dissertation in a presentation open to the public. The details of the individual dissertation and defense are up to the advisor and PhD student, and subject to the requirements available on the TGS website.

Clinical Investigation
https://www.nucats.northwestern.edu/education-and-career-development/investigator-development/adaptive/index.html

Degree Types: MS
The Degree Program in Clinical Investigation is sponsored by the Northwestern University Clinical and Translational Sciences (NUCATS) institute.

This program is part-time and consists of evening courses primarily for medical residents, fellows and junior faculty members who wish to receive formal training in clinical research. Other medical professionals in the Chicago area may be eligible to enroll. All program participants are expected to be actively engaged in research with a mentor, preferably one at NU, who should have national funding—NIH, AHA, etc. MSCI courses are open to graduate students in other life sciences’ programs at NU to explore the application of basic science concepts to medicine. Students can enter the program at the beginning of any of the four quarters.

The program provides rigorous education in quantitative and ethically sound methods for the design, implementation, analysis, and publication of clinical research studies. In addition to courses in clinical trials and grant writing, students take courses in biostatistics, epidemiology, translational research, and medical writing.

Our faculty, who engage in clinical research training and participate in course design and instruction, are drawn from various departments including medicine, pediatrics, psychiatry, pulmonary, and neurology.

Degrees Offered
- Clinical Investigation MS (p. 40)

Clinical Investigation MS

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).
Master's

Total Units Required: 10

Eight units of classroom courses and two units comprising a mentored clinical research project that must be submitted for publication are required. Because courses are offered during all four quarters of the year, including summer, the degree can be accomplished over the course of two years. Students are expected to take one classroom course per quarter and be engaged in a mentored research project by the second quarter of classes.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSCI 321-1</td>
<td>Biostatistics for Clinical Investigators 1</td>
</tr>
<tr>
<td>MSCI 311-0</td>
<td>Clinical Research Design, Methods, and Grant Writing</td>
</tr>
<tr>
<td>MSCI 421-0</td>
<td>Biostatistics for Clinical Investigators 2</td>
</tr>
<tr>
<td>MSCI 322-0</td>
<td>Introduction to Epidemiology for Clinical Investigators</td>
</tr>
<tr>
<td>MSCI 330-0</td>
<td>Electronic Health Record Data as a Foundation for</td>
</tr>
<tr>
<td></td>
<td>Clinical Research</td>
</tr>
<tr>
<td>MSCI 445-0</td>
<td>Writing &amp; Peer Reviewing for Publication for Clinical</td>
</tr>
<tr>
<td></td>
<td>Investigators</td>
</tr>
<tr>
<td>MSCI 499-0</td>
<td>Research Project</td>
</tr>
<tr>
<td>MSCI 422-0</td>
<td>Introduction to Translational Research</td>
</tr>
<tr>
<td>MSCI 490-0</td>
<td>Independent Study</td>
</tr>
</tbody>
</table>

Other Degree Requirements
• Research/Projects: Research/Projects: Students must complete two units comprising a mentored clinical research project. This project must be submitted for publication before the student can graduate.

Clinical Psychology

https://www.psychiatry.northwestern.edu/

Degree Types: MA, PhD

The PhD Program in Clinical Psychology (https://www.psychiatry.northwestern.edu/education/clinical-psychology-phd) is one of only a handful of programs in the United States based in an academic medical center and housed in a psychiatry department. This unique setting provides opportunities for translational research and practice that span molecular to social models of disease, and epidemiologic to clinical and neuroimaging methodologies.

This scientist-practitioner program effectively balances clinical and research training to produce graduates who are competent in the science and practice of clinical psychology. Training is provided through core and emphasis-specific curricula, intensive research mentoring, and exceptional clinical practica. Major milestones include a research qualifying paper, a clinical qualifying exam, an empirical dissertation with original research, and an APA-accredited clinical internship.

Our mentor-based program prepares students to be competitive for careers as clinical psychologists in academic health centers and related medical facilities.

The Clinical Psychology Master of Arts (MA) Program (https://www.psychiatry.northwestern.edu/education/clinical-psychology-ma) within the Department of Psychiatry and Behavioral Sciences at Northwestern University Feinberg School of Medicine is intended for students interested in pursuing a career in academic clinical psychology. The MA program is designed to provide a foundation in academic clinical psychology at the graduate level, while also allowing students to gain educational and research exposure to major areas of study within clinical psychology, including Adult Psychopathology and Treatment, Health Psychology/Behavioral Medicine, Clinical Child and Adolescent Psychology, and Clinical Neuropsychology and Behavioral Neuroscience.

The goals of the MA Program in Clinical Psychology are to:
1. Develop foundational competencies in research design, analytics, and ethics within academic clinical psychology.
2. Explore major areas of study within academic clinical psychology.
3. Understand educational and career opportunities within academic clinical psychology.

Note: the MA Program in Clinical Psychology does not include clinical training and is not intended to prepare students for clinical practice. Given the academic and research focus of the MA Program, the degree will not lead to licensure for independent practice. For those interested in master's level programs that prepare students for licensure and practice, please visit the MA in Counseling website (https://www.family-institute.org/graduate-education/master-arts-counseling), the MS in Marriage and Family Therapy website (https://www.family-institute.org/graduate-education/master-science-marriage-family-therapy) and The Family Institute website (https://www.family-institute.org).

The MA Program in Clinical Psychology was designed for a variety of students, including students who:
1. Are not yet ready to apply to a PhD program, but are considering doing so in the future.
2. Wish to improve their competitiveness for a PhD program.
3. Are interested in exploring a career in academic clinical psychology.
4. With interests in related fields for which a background in academic clinical psychology may be of value.

The MA Program is embedded in the Clinical Psychology PhD Program, with coursework and lab work completed alongside PhD students. Although students in the MA Program are welcome to apply to the PhD Program in Clinical Psychology, the MA Program is not intended to be a "gateway" into the PhD Program in Clinical Psychology at Northwestern University Feinberg School of Medicine.

Degrees Offered
• Clinical Psychology MA (p. 41)
• Clinical Psychology PhD (p. 42)

Clinical Psychology MA

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

MA Degree Requirements
Total Units Required: 17

The MA program requires at least 17 units for graduation. Students are required to take the Research Core, including Research Methods/Statistics (3 units), Advanced Research Methodology (1 unit), and Scientific and Professional Ethics in Psychology (1 unit). In addition to these required courses, students are expected to select between five to eight elective courses across the Fall, Winter, Spring, and/or Summer
II quarters. Elective courses can include courses at the Foundational, Bases of Behavior, or Clinical level, as well as courses in one or more of the emphases or Major Areas of Study.

In addition to the Research Core and Elective courses, all MA students participate in the weekly Career Development Proseminar for the first four quarters of the MA Program. The Proseminar orients students to the MA program, introduces students to various mentors and labs across Northwestern, explores career options in academic clinical psychology, refines interests in academic clinical psychology, and prepares students for the next steps in their careers (e.g., developing applications for PhD programs; preparing for interviews).

Other MA Degree Requirements

- **Research/Projects:** In addition to completion of the coursework requirements, students engage in a Research Lab Experience for at least 10 hours a week.

- **Master's Thesis:** Optional (see below)

- **Master's Culinating Academic Experience:** Through the Research Lab Experience, the student will work with her or his research mentor to complete a Capstone Project. The Capstone Project is the culmination of the Research Lab Experience provided by the research mentor, providing the final evaluation of the student's research competencies. Examples of capstone projects include: Substantial participation (i.e., authorship level) on one or more empirical studies submitted for publication in a peer-reviewed journal. First author submission of one or more peer-reviewed poster/oral presentations at regional, national, or international conferences. A comprehensive review paper that is submitted to and graded by the research mentor. A grant proposal (e.g., F31 style) that is submitted to and graded by the research mentor.

### Clinical Psychology PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**PhD Degree Requirements**

**Total Units Required:** 30

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLIN_PSY 402-0</td>
<td>Psychological Assessment I</td>
</tr>
<tr>
<td>CLIN_PSY 403-0</td>
<td>Psychological Assessment II</td>
</tr>
<tr>
<td>CLIN_PSY 404-0</td>
<td>Psychological Assessment III</td>
</tr>
<tr>
<td>CLIN_PSY 411-0</td>
<td>History and Systems of Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 412-1</td>
<td>Cognitive Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 413-0</td>
<td>Advanced Social Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 414-0</td>
<td>Diversity in Psychological Science and Practice</td>
</tr>
<tr>
<td>CLIN_PSY 415-1</td>
<td>Scientific and Professional Ethics in Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 416-0</td>
<td>Psychopathology</td>
</tr>
<tr>
<td>CLIN_PSY 408-0</td>
<td>Psychopathology Laboratory</td>
</tr>
<tr>
<td>CLIN_PSY 426-0</td>
<td>Research Methods I</td>
</tr>
<tr>
<td>CLIN_PSY 427-0</td>
<td>Research Methods II</td>
</tr>
<tr>
<td>CLIN_PSY 428-0</td>
<td>Research Methods III</td>
</tr>
<tr>
<td>CLIN_PSY 429-0</td>
<td>Advanced Research Methodology</td>
</tr>
<tr>
<td>CLIN_PSY 441-0</td>
<td>Introduction to Psychotherapy</td>
</tr>
<tr>
<td>CLIN_PSY 444-0</td>
<td>Cognitive-Behavior Therapies</td>
</tr>
<tr>
<td>CLIN_PSY 417-0</td>
<td>Behavioral Neuroscience</td>
</tr>
<tr>
<td>CLIN_PSY 487-0</td>
<td>Life-Span Developmental Psychology</td>
</tr>
</tbody>
</table>

Electives (14 units), including:

- CLIN_PSY 498-0 Special Topics in Clinical Psychology
- CLIN_PSY 499-0 Independent Study
- CLIN_PSY 590-0 Research

**Other PhD Degree Requirements**

- **Examinations:** defense of a research paper and a clinical qualifying project serving as examination for admission to candidacy
- **Research/Projects:** independent, empirical research study completed in fulfillment of the research qualifying paper
- **PhD Dissertation:** original research following third year of coursework
- **Final Evaluations:** oral defense of dissertation

### Communication Sciences and Disorders and Audiology PhD/AuD

[https://www.aud.northwestern.edu/](https://www.aud.northwestern.edu/)

**Degree Types:** PhD/AuD

The Graduate School and School of Communication at Northwestern offer a dual PhD and AuD program for students interested in pursuing a career in academia or another research setting. The Communication Sciences and Disorders and Audiology combined PhD/AuD provides strong training in scientific research in human communication and its disorders along with the knowledge and skills necessary for clinical practice in audiology. This program is designed to provide continuous integrated training in basic research and audiology practice in order to foster scientist-clinicians who can readily recognize synergies between the scientific and clinical worlds and contribute to both.

The program's curriculum allows students to complete both degrees more efficiently than they would through consecutive degree programs. Students can complete the entire program (including dissertation) in as few as seven years.

**Degrees Offered**

- Communication Sciences and Disorders and Audiology PhD/AuD (p. 42)

### Communication Sciences and Disorders and Audiology PhD/AuD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Course Requirements**

**Total Units Required for PhD:** 11 didactic courses, 1 ethics (non-credit bearing), 3 lab experiences, 3 independent studies

**Total Units Required for AuD:** 21 didactic courses (18 credits), 4 clinical courses (3 credits), 12 practicum courses

**PhD Didactic Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD 550-1</td>
<td>Research Foundations in Communication Sciences and Disorders</td>
</tr>
<tr>
<td>CLIN_PSY 402-0</td>
<td>Psychological Assessment I</td>
</tr>
<tr>
<td>CLIN_PSY 403-0</td>
<td>Psychological Assessment II</td>
</tr>
<tr>
<td>CLIN_PSY 404-0</td>
<td>Psychological Assessment III</td>
</tr>
<tr>
<td>CLIN_PSY 411-0</td>
<td>History and Systems of Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 412-1</td>
<td>Cognitive Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 413-0</td>
<td>Advanced Social Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 414-0</td>
<td>Diversity in Psychological Science and Practice</td>
</tr>
<tr>
<td>CLIN_PSY 415-1</td>
<td>Scientific and Professional Ethics in Psychology</td>
</tr>
<tr>
<td>CLIN_PSY 416-0</td>
<td>Psychopathology</td>
</tr>
<tr>
<td>CLIN_PSY 408-0</td>
<td>Psychopathology Laboratory</td>
</tr>
<tr>
<td>CLIN_PSY 426-0</td>
<td>Research Methods I</td>
</tr>
<tr>
<td>CLIN_PSY 427-0</td>
<td>Research Methods II</td>
</tr>
<tr>
<td>CLIN_PSY 428-0</td>
<td>Research Methods III</td>
</tr>
<tr>
<td>CLIN_PSY 429-0</td>
<td>Advanced Research Methodology</td>
</tr>
<tr>
<td>CLIN_PSY 441-0</td>
<td>Introduction to Psychotherapy</td>
</tr>
<tr>
<td>CLIN_PSY 444-0</td>
<td>Cognitive-Behavior Therapies</td>
</tr>
<tr>
<td>CLIN_PSY 417-0</td>
<td>Behavioral Neuroscience</td>
</tr>
<tr>
<td>CLIN_PSY 487-0</td>
<td>Life-Span Developmental Psychology</td>
</tr>
</tbody>
</table>
### AuD Didactic Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD 302-0</td>
<td>Anatomy and Physiology of the Peripheral Hearing Mechanism</td>
</tr>
<tr>
<td>CSD 306-0</td>
<td>Psychoacoustics</td>
</tr>
<tr>
<td>CSD 401-0</td>
<td>Signals, Systems and Acoustics for the Communication Sciences</td>
</tr>
<tr>
<td>CSD 406-0</td>
<td>Medical Aspects of Audiology</td>
</tr>
<tr>
<td>CSD 407-0</td>
<td>Implantable Devices</td>
</tr>
<tr>
<td>CSD 408-1</td>
<td>Business Practices in Audiology</td>
</tr>
<tr>
<td>CSD 408-2</td>
<td>Business in Audiology</td>
</tr>
<tr>
<td>CSD 411-0</td>
<td>Evaluation and Use of Amplification Systems</td>
</tr>
<tr>
<td>CSD 414-0</td>
<td>Amplification Systems II</td>
</tr>
<tr>
<td>CSD 419-0</td>
<td>Pediatric Audiology</td>
</tr>
<tr>
<td>CSD 420-0</td>
<td>Pathologies of the Auditory System</td>
</tr>
<tr>
<td>CSD 422-0</td>
<td>Anatomy and Physiology of the Central Hearing Mechanism</td>
</tr>
<tr>
<td>CSD 423-0</td>
<td>Evaluation of the Peripheral Hearing Mechanism</td>
</tr>
<tr>
<td>CSD 424-0</td>
<td>Central Auditory Processing Disorders</td>
</tr>
<tr>
<td>CSD 425-0</td>
<td>Electrophysiology of the Human Auditory System</td>
</tr>
<tr>
<td>CSD 427-0</td>
<td>Otocoustic Emissions: Theory and Practice</td>
</tr>
<tr>
<td>CSD 428-0</td>
<td>Fundamentals of Vestibular Science</td>
</tr>
<tr>
<td>CSD 429-0</td>
<td>Evaluation and Treatment of Balance Disorders</td>
</tr>
<tr>
<td>CSD 519-0</td>
<td>Pediatric Amplification</td>
</tr>
<tr>
<td>CSD 522-0</td>
<td>Hearing Loss Prevention and Conservation</td>
</tr>
<tr>
<td>CSD 523-0</td>
<td>Assessment and Management of Tinnitus and Sound Tolerance Issues</td>
</tr>
</tbody>
</table>

### AuD Clinical Courses

#### Course

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD 409-3</td>
<td>Foundations of Clinical and Professional Practice (Integration)</td>
</tr>
<tr>
<td>CSD 409-5</td>
<td>Foundations of Clinical and Professional Practice (Supervision and Counseling)</td>
</tr>
<tr>
<td>CSD 409-6</td>
<td>Foundations of Clinical and Professional Practice (Ethics and Counseling)</td>
</tr>
<tr>
<td>CSD 409-7</td>
<td>Foundations of Clinical and Professional Practice (Alternative Delivery Models and Counseling)</td>
</tr>
</tbody>
</table>

### AuD Practicum Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD 415-1</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-2</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-3</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-4</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-5</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-6</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-7</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 415-8</td>
<td>Clinical Practicum in Audiology</td>
</tr>
<tr>
<td>CSD 580-1</td>
<td>Clinical Externship</td>
</tr>
<tr>
<td>CSD 580-2</td>
<td>Clinical Externship</td>
</tr>
<tr>
<td>CSD 580-3</td>
<td>Clinical Externship</td>
</tr>
<tr>
<td>CSD 580-4</td>
<td>Clinical Externship</td>
</tr>
</tbody>
</table>

### Other PhD Degree Requirements

- **Attendance at Scientific Lectures**: four scientific lectures per quarter
- **Non-Course Assignments**: teaching assistantships and/or research assistantships
- **Research Presentations**: oral presentation of ongoing work at Annual Doctoral Student Research Presentation Days
- **Qualifying Research Project (QRP)**: a minimum of three quarters of independent study; proposal, paper, exam, and defense
- **Doctoral Dissertation**: prospectus and prospectus meeting prior to conducting dissertation research project; paper and defense at the conclusion of the dissertation research project

For details on PhD in CSD degree requirements, please refer to the program handbook (http://www.communication.northwestern.edu/sites/default/files/phd-csd/handbook.pdf). (http://www.communication.northwestern.edu/sites/default/files/phd-csd/handbook.pdf)

### Other AuD Degree Requirements

- **Written qualifying exam**: assessment of clinical knowledge base
- **Practical exams**: assessment of hands-on clinical skills
- **Written comprehensive exam**: assessment of knowledge of clinical integration and evidence-based practice
- **Full-time clinical placement**: registration in CSD 580-1 Clinical Externship, CSD 580-2 Clinical Externship, CSD 580-3 Clinical Externship, and CSD 580-4 Clinical Externship

### Simultaneous Award of PhD and AuD

Students will receive both the PhD and AuD degrees simultaneously after all of the requirements for both degrees are complete. Students who leave the program early will receive the non-clinical Master's degree in Communication Sciences and Disorders (MA), as deemed appropriate by their progress, following current practice in the PhD program.
Communication Sciences and Disorders

https://communication.northwestern.edu/programs/phd_communication_sciences_disorders/about.php

Degree Types: PhD

The Department of Communication Sciences and Disorders (https://communication.northwestern.edu/programs/phd_communication_sciences_disorders/about.php) at Northwestern brings together researchers studying mechanisms and disorders of communication in an interdisciplinary setting. Research centers around basic and clinical aspects of speech, language, learning, hearing, and swallowing, but disciplines span physics, engineering, physiology, neuroscience, linguistics, biology, psychology, cognitive science, and education. Investigations range from the level of molecules to clinical trials.

The PhD program is designed to prepare the next generation of leaders in the field by providing coursework and in-depth research experience. Developing critical thinking, scientific writing, publishing, and grant-writing skills are major emphases throughout the program. Opportunities are available to develop skills through training in related areas such as statistics, programming, big data/data science, teaching, and clinical training in audiology (PhD-AuD). Students are prepared for careers in academia as well as industry, policy, and clinical practice.

Degrees Offered
• Communication Sciences and Disorders Audiology PhD/AuD (p. 42)
• Communication Sciences and Disorders PhD (p. 44)

Communication Sciences and Disorders PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Course Requirements
Total Units Required: 11 didactic, 1 ethics (non-credit bearing), 3 lab experiences, 3 independent studies

PhD Didactic Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD 412-0</td>
<td>Scientific Writing</td>
</tr>
<tr>
<td>CSD 544-0</td>
<td>Responsible Conduct of Research in Communication Sciences and Disorders</td>
</tr>
<tr>
<td>CSD 545-0</td>
<td>Seminar: Professional Development</td>
</tr>
<tr>
<td>Content Courses (2 required)</td>
<td></td>
</tr>
<tr>
<td>Topic Seminars (2 required)</td>
<td></td>
</tr>
</tbody>
</table>

PhD Research Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD 551-1</td>
<td>Laboratory Experiences in Communication Sciences and Disorders</td>
</tr>
<tr>
<td>CSD 552-1</td>
<td>Laboratory Experiences in Communication Sciences and Disorders</td>
</tr>
<tr>
<td>CSD 553-1</td>
<td>Laboratory Experiences in Communication Sciences and Disorders</td>
</tr>
</tbody>
</table>

Independent Study (related to Qualifying Research Project)
CSD 499-0 Independent Study (for 3 quarters)

Other PhD Degree Requirements
• Attendance at Scientific Lectures: four scientific lectures per quarter
• Non-Course Assignments: teaching assistantships and/or research assistantships
• Research Presentation: oral presentation of ongoing work at Annual Doctoral Student Research Presentation Days
• Qualifying Research Project (QRP): a minimum of three quarters of independent study; proposal, paper, exam, and defense
• Doctoral Dissertation: prospectus and prospectus meeting prior to conducting dissertation research project; paper and defense at the conclusion of the dissertation research project

For details on PhD in CSD degree requirements, please refer to the program handbook (http://www.communication.northwestern.edu/sites/default/files/phd-csd/handbook.pdf).

Communication Studies

https://communication.northwestern.edu/programs/phd_communication_studies/

Degree Types: PhD

The Department of Communication Studies houses the doctoral program in Rhetoric and Public Culture. The Department is also a key participant in the doctoral programs in Media, Technology and Society (https://communication.northwestern.edu/programs/phd_media_technology_society) and Technology and Social Behavior (https://tsb.northwestern.edu).

A concentration in Rhetoric and Public Culture enables students to explore how texts, images, and other media function as modes of action, with particular regard to those practices that organize public thought, identities, and social relations. Faculty and student research is interdisciplinary and participates in a range of contemporary theoretical discussions, paying special attention to how power and legitimacy are negotiated rhetorically. Program conversations attend carefully to the impact of social differences as organized by particular constructions of race, class, sexuality, gender, locale, and other variables.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Cluster Initiative program. For more information on how you can have a second intellectual “home” outside of your department
or program, please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).

 Degrees Offered
 • Communication Studies PhD (p. 45)

 Communication Studies PhD
 Degree Requirements
 The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

 PhD
 Total Units Required: Students entering with a BA typically take 27 courses. Students entering with an MA typically take 18 courses.

 1. Three Required Seminars
 • Proseminar
 • Modes of Cultural Analysis
 • Classical Rhetoric and its Afterlives
 2. Additional courses to comprise the student’s full course of study are selected with the assistance of the temporary advisor and then with the dissertation advisor. It is assumed that many of these courses will be taught by core RPC faculty, but others can be taught by faculty in Communication Studies more generally or by faculty from around the university. Students typically take three courses per quarter for a total of nine per academic year.

 NOTE: Students without an MA or equivalent degree must complete either a master's thesis, master's project, or written examination en route to the PhD

 Other PhD Degree Requirements
 • Three qualifying examinations
 • Oral defense of the qualifying examinations
 • Dissertation prospectus
 • Oral defense of the dissertation prospectus
 • Dissertation
 • Oral defense of the dissertation

 Comparative Literary Studies
 https://www.complit.northwestern.edu/graduate/

 Degree Types: PhD

 Graduates of Comparative Literary Studies leave with the historical knowledge, linguistic skills, and interpretive methodologies necessary to undertake scholarly research on and to teach literature in at least two languages.

 The graduate faculty (drawn from all of Weinberg College’s literature departments, as well as art history and the School of Communication’s Department of Radio/Television/Film), offer courses and mentoring in a wide array of literary fields, including African, Middle Eastern, and Latin American as well as European and English-language literature. The program’s methodological areas of strength include classical traditions, critical theory, modernism, poetry and poetics, and visual culture and media.

 In addition to their studies within the program, students also take coursework and qualifying examinations in their chosen “home department,” which provides training comparable to that of a PhD in a national literary field, qualifying graduates to work in national language and literature departments. Students’ teaching and research assistantship opportunities are coordinated with their specific goals. Current home departments can be found on the Comparative Literary Studies Graduate page (https://www.complit.northwestern.edu/graduate).

 Many of our students participate in TGS’s Interdisciplinary Cluster Initiative program, which provides an additional interdisciplinary intellectual “home.” Please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).

 Degrees Offered
 • Comparative Literary Studies PhD (p. 45)

 Comparative Literary Studies PhD
 Degree Requirements
 The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

 PhD
 Total Units Required: 15-18

 Course Title
 CLS theory sequence taken in first year (3 units)
 COMP_LIT 410-0 Theories of Literature
 COMP_LIT 411-0 Critical Practices
 COMP_LIT 412-0 Literary Studies Colloquium
 Home department (6 units)
 Electives (in CLS, home department, or other graduate programs; 6-9 units)

 Other PhD Degree Requirements
 • Examinations: theory exam by Fall quarter of second year; broad-based qualifying exam in home department by end of third year; dissertation prospectus by end of fourth year
 • Research/Projects: public presentation of a comparative paper in the third year
 • Language: Proficiency in two languages other than native language by end of third year
 • PhD Dissertation: original, independent research
 • Final Evaluations: defense of dissertation

 Computer Engineering
 https://mccormick.northwestern.edu/electrical-computer/ https://mccormick.northwestern.edu/computer-science/

 Degree Types: MS, PhD

 Northwestern University’s Computer Engineering (https://www.mccormick.northwestern.edu/electrical-computer/research/areas/computer-engineering.html) program is a joint program between the Department of Computer Science (https://www.mccormick.northwestern.edu/computer-science/graduate) (CS) and the Department of Electrical and Computer Engineering (https://
mccormick.northwestern.edu/electrical-computer) (ECE), and offers programs leading to the MS and PhD degrees in Computer Engineering (CE). Computer Engineering covers a diverse set of areas including, but not limited to, integrated circuits/VLSI, computer architecture, computer systems, operating systems, compilers, data mining, high-performance and parallel computing, distributed computing, design automation, embedded systems, reconfigurable systems, mobile and wearable computing, internet of things, cyber-physical systems, real-time systems, and database systems.

The broad interdisciplinary interests of our faculty lead to strong collaborative research with other engineering and science departments, the Feinberg School of Medicine (https://www.feinberg.northwestern.edu), national laboratories including Argonne National Laboratory (https://www.anl.gov), Fermi National Accelerator Laboratory (http://www.fnal.gov), Sandia National Laboratories (https://www.sandia.gov) and Oak Ridge National Laboratory (https://www.ornl.gov), as well as industry.

When applying to the PhD or MS program (https://www.mccormick.northwestern.edu/electrical-computer/graduate), students should specify CE as the specific program which will represent their major field of study.

### Degrees Offered
- Computer Engineering MS (p. 46)
- Computer Engineering PhD (p. 48)

### Computer Engineering MS

#### Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**MS Degree Options**

There are three MS degree plans available: Thesis, Project, and Course-only. Students declare their intention to follow one of the degree plans no later than May 1st of the 3rd academic quarter (typically spring).

**Common Requirements**

For all three plans, the following are required:

- A total of 12 units.
- All courses must be at the 300-level or higher, and must be taken within The Graduate School (TGS) of Northwestern University.
- COMP_SCI 301-0 Introduction to Robotics Laboratory and ELEC_ENG 302-0 Probabilistic Systems do not count toward the CE MS degree. They are intended for undergraduate students only.
- At least 9 units from Computer Engineering, Electrical Engineering, or Computer Science.
- Any courses taken outside Computer Engineering, Electrical Engineering, or Computer Science must be approved by the student’s adviser and the Director of Graduate Studies in Computer Engineering.
- At least 6 units from the **Core Computer Engineering** list below.

- At least 3 units at the 400-level or above (COMP_ENG 590-0 Research and COMP_ENG 499-0 Projects do not count toward these units).
- At most 3 units of COMP_ENG 499-0 Projects.
- The only P/N course acceptable for the master’s degree program is COMP_ENG 590-0 Research.
- All coursework must be completed with a composite grade-point average of B (GPA 3.0) or higher.
- Courses completed for undergraduate credit at Northwestern University or elsewhere cannot be repeated for graduate credit.
- Additional requirements are listed in the Computer Engineering Graduate Study Guide (https://www.mccormick.northwestern.edu/electrical-computer/graduate/masters/requirements.html).

**Plan 1: Thesis**

Additional requirements:

- Up to **three** credits may be COMP_ENG 590-0 Research.
- A **written thesis** is required, in a format specified by the MS Thesis Committee. The thesis must show evidence of original research and must be approved by the MS Thesis Committee.
- An **oral defense** of the thesis research is required. The oral defense is attended and evaluated by the MS Thesis Committee.
- All requirements, including coursework and the approval of the thesis, must be successfully completed before the end of the 7th academic quarter (typically the spring quarter of the 2nd year of study).
- **IMPORTANT:** In the spring term, the Graduate School requires that all thesis defenses be completed **ONE MONTH** before the end of the quarter, if the student is to graduate in the spring term. Deadlines in other quarters are not as early. Consult the Office of the Registrar’s academic calendar (https://www.registrar.northwestern.edu/calendars/academic-calendars) for thesis defense deadlines for each quarter.

**Plan 2: Project**

Additional requirements:

- Up to **two** credits may be COMP_ENG 590-0 Research.
- A **project report** is required, in a format specified by the MS Project Committee. The project report must contain results based on existing theory and techniques or experimental verifications and must be approved by the MS Project Committee.
- All requirements, including coursework and the approval of the project report, must be successfully completed before the end of the 6th academic quarter (typically the winter quarter of the 2nd year of study).

**Plan 3: Course-only**

Additional requirements:

- COMP_ENG 590-0 Research may **not** be included in the 12 required units.
- The required 12 course units must be approved by the student’s adviser. The choice of courses must represent a coherent program of study that prepares the student for advanced work in a specific field.
- All requirements must be successfully completed before the end of the 6th academic quarter (typically the fall quarter of the 2nd year of study).
Courses

Core Computer Engineering Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_ENG 303-0</td>
<td>Advanced Digital Design</td>
</tr>
<tr>
<td>COMP_ENG 329-0</td>
<td>The Art of Multicore Concurrent Programming</td>
</tr>
<tr>
<td>COMP_ENG 346-0</td>
<td>Microprocessor System Design</td>
</tr>
<tr>
<td>COMP_ENG 347-1</td>
<td>Microprocessor Systems Project I</td>
</tr>
<tr>
<td>COMP_ENG 347-2</td>
<td>Microprocessor Systems Project II</td>
</tr>
<tr>
<td>COMP_ENG 355-0</td>
<td>ASIC and FPGA Design</td>
</tr>
<tr>
<td>COMP_ENG 356-0</td>
<td>Introduction to Formal Specification &amp; Verification</td>
</tr>
<tr>
<td>COMP_ENG 357-0</td>
<td>Design Automation in VLSI</td>
</tr>
<tr>
<td>COMP_ENG 358-0</td>
<td>Introduction to Parallel Computing</td>
</tr>
<tr>
<td>COMP_ENG 361-0</td>
<td>Computer Architecture I</td>
</tr>
<tr>
<td>COMP_ENG 362-0</td>
<td>Computer Architecture Projects</td>
</tr>
<tr>
<td>COMP_ENG 364-0</td>
<td>CyberPhysical Systems Design and Application</td>
</tr>
<tr>
<td>COMP_ENG 365-0</td>
<td>Internet-of-things Sensors, Systems, And Applications</td>
</tr>
<tr>
<td>COMP_ENG 366-0</td>
<td>Embedded Systems</td>
</tr>
<tr>
<td>COMP_ENG 368-0</td>
<td>Programming Massively Parallel Processors with CUDA</td>
</tr>
<tr>
<td>COMP_ENG 391-0</td>
<td>CMOS VLSI Circuit Design</td>
</tr>
<tr>
<td>COMP_ENG 392-0</td>
<td>VLSI Systems Design Projects</td>
</tr>
<tr>
<td>COMP_ENG 393-0</td>
<td>Advanced Low Power VLSI and Mixed-signal IC Design</td>
</tr>
<tr>
<td>COMP_ENG 452-0</td>
<td>Adv Computer Architecture</td>
</tr>
<tr>
<td>COMP_ENG 453-0</td>
<td>Parallel Architectures</td>
</tr>
<tr>
<td>COMP_ENG 456-0</td>
<td>Modern Topics in Computer Architecture</td>
</tr>
<tr>
<td>COMP_ENG 459-0</td>
<td>VLSI Algorithms</td>
</tr>
<tr>
<td>COMP_ENG 464-0</td>
<td>Cyber-Physical Systems Design and Application</td>
</tr>
<tr>
<td>COMP_ENG 465-0</td>
<td>Internet-of-things Sensors, Systems, And Applications</td>
</tr>
<tr>
<td>COMP_ENG 466-0</td>
<td>Embedded Systems</td>
</tr>
<tr>
<td>COMP_ENG 468-0</td>
<td>Programming Massively Parallel Processors with CUDA</td>
</tr>
<tr>
<td>COMP_ENG 493-0</td>
<td>Advanced Low Power VLSI and Mixed-signal IC Design</td>
</tr>
<tr>
<td>COMP_ENG 510-0</td>
<td>Seminar</td>
</tr>
<tr>
<td>COMP_ENG 395-0</td>
<td>Special Topics in Computer Engineering (Blockchain and Cryptocurrency, Advanced Digital System Design with FPGAs, Connected and Autonomous Vehicles: Challenges and Design)</td>
</tr>
<tr>
<td>COMP_ENG 495-0</td>
<td>Special Topics in Computer Engineering (Blockchain and Cryptocurrency, Advanced Digital System Design with FPGAs, Connected and Autonomous Vehicles: Challenges and Design)</td>
</tr>
</tbody>
</table>

Any non-zero-credit 300-level or above course taught by Core Computer Engineering Faculty:

- Simone Campanoni
- Alok Choudhary
- Peter Dinda
- Jie Gu
- Nikos Hardavellas
- Larry Henschen
- Josiah Hester
- Russ Joseph
- Gokhan Memik
- Seda Ogrenci-Memik
- Stephen Tarzia

Core CE offerings from CS:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_SCI 321-0</td>
<td>Programming Languages</td>
</tr>
<tr>
<td>COMP_SCI 322-0</td>
<td>Compiler Construction</td>
</tr>
<tr>
<td>COMP_SCI 323-0</td>
<td>Code Analysis and Transformation</td>
</tr>
<tr>
<td>COMP_SCI 336-0</td>
<td>Design &amp; Analysis of Algorithms</td>
</tr>
<tr>
<td>COMP_SCI 339-0</td>
<td>Introduction to Database Systems</td>
</tr>
<tr>
<td>COMP_SCI 340-0</td>
<td>Introduction to Networking</td>
</tr>
<tr>
<td>COMP_SCI 343-0</td>
<td>Operating Systems</td>
</tr>
<tr>
<td>COMP_SCI 350-0</td>
<td>Introduction to Computer Security</td>
</tr>
<tr>
<td>COMP_SCI 354-0</td>
<td>Network Penetration &amp; Security</td>
</tr>
<tr>
<td>COMP_SCI 367-0</td>
<td>Wireless and Mobile Health: Passive Sensing Data Analytics</td>
</tr>
<tr>
<td>COMP_SCI 446-0</td>
<td>Kernel and Other Low-level Software Development</td>
</tr>
<tr>
<td>COMP_SCI 396-0</td>
<td>Special Topics in Computer Science (Only: Systems Programming in Rust, Computational Geometry, Data Science Seminar, Special Topics in Swarms and Multi-robot Systems, Quadrotor Design and Control, Programming Languages Seminar)</td>
</tr>
<tr>
<td>COMP_SCI 496-0</td>
<td>Special Topics in Computer Science (Only: Systems Programming in Rust, Computational Geometry, Data Science Seminar, Special Topics in Swarms and Multi-robot Systems, Quadrotor Design and Control, Programming Languages Seminar)</td>
</tr>
<tr>
<td>COMP_SCI 397-0</td>
<td>Special Projects in Computer Science (Only: Advanced Topics in Compilers, Internet of Things Networks Seminar, Wireless and Mobile Health)</td>
</tr>
<tr>
<td>COMP_SCI 497-0</td>
<td>Special Projects in Computer Science (Only: Advanced Topics in Compilers, Internet of Things Networks Seminar, Wireless and Mobile Health)</td>
</tr>
</tbody>
</table>

Core CE offerings from EE:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEC_ENG 326-0</td>
<td>Electronic System Design I</td>
</tr>
<tr>
<td>ELEC_ENG 327-0</td>
<td>Electronic System Design II</td>
</tr>
<tr>
<td>ELEC_ENG 332-0</td>
<td>Introduction to Computer Vision</td>
</tr>
<tr>
<td>ELEC_ENG 375-0</td>
<td>Machine Learning: Foundations, Applications, and Algorithms</td>
</tr>
<tr>
<td>ELEC_ENG 475-0</td>
<td>Machine Learning: Foundations, Applications, and Algorithms</td>
</tr>
<tr>
<td>ELEC_ENG 390-0</td>
<td>Introduction to Robotics</td>
</tr>
<tr>
<td>ELEC_ENG 395-0</td>
<td>Special Topics in Electrical Engineering (Only: Blockchain and Cryptocurrency, Biometrics, Introduction to Database Systems)</td>
</tr>
<tr>
<td>ELEC_ENG 495-0</td>
<td>Special Topics in Electrical Engineering (Only: Blockchain and Cryptocurrency, Biometrics, Introduction to Database Systems)</td>
</tr>
</tbody>
</table>

BS/MS Option for Northwestern Students

Northwestern students that wish to pursue a MS in Computer Engineering must have successfully passed the following courses:

- COMP_ENG 203-0 Introduction to Computer Engineering or COMP_ENG 303-0 Advanced Digital Design.
- COMP_ENG 205-0 Fundamentals of Computer System Software or COMP_SCI 213-0 Introduction to Computer Systems.
- COMP_SCI 211-0 Fundamentals of Computer Programming II.
# Computer Engineering PhD
## Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

### Course Requirements

- **Total Units Required:** 15 units that count for graduate (TGS) credit.
  - The cumulative grade point average over these 15 units must be a B (3.0 GPA) or higher.
  - Complete the zero-credit GEN_ENG 519-0 Responsible Conduct for Research Training during their first year.
  - In each quarter, the study plan should be approved by the student's adviser prior to registration.

- **Restrictions:**
  - COMP_ENG 590-0 Research does not count toward the 15 units requirement.
  - At most 2 units of COMP_ENG 499-0 Projects can be counted toward the 15 units requirement.
  - At least 6 of the required 15 units should be from 400- or 500-level courses.
  - All "Core Courses" below are mandatory and count toward the 15 units requirement.
  - At least 6 of the required 15 units should be from the "Track Courses" category below.

### Core Courses (1 unit)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_ENG 361-0</td>
<td>Computer Architecture I</td>
</tr>
</tbody>
</table>

### Track Courses (6 units)

- These courses must fulfill at least three of the six tracks.
- A track is fulfilled when the student completes at least two of the track's courses. The Computer Architecture track requires only one additional course to be completed (the CE Core Course counts toward completing the Computer Architecture track).
- A course that is listed in two different tracks can fulfill both track requirements, but can be counted only once toward the 6 units.
- Additional 300- and 400-level and above courses can fulfill track requirements with the consent of the adviser and the Director of Graduate Studies in Computer Engineering.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_ENG 303-0</td>
<td>Advanced Digital Design</td>
</tr>
<tr>
<td>COMP_ENG 350-0</td>
<td>ASIC and FPGA Design</td>
</tr>
<tr>
<td>COMP_ENG 357-0</td>
<td>Design Automation in VLSI</td>
</tr>
<tr>
<td>COMP_ENG 391-0</td>
<td>CMOS VLSI Circuit Design</td>
</tr>
<tr>
<td>COMP_ENG 393-0</td>
<td>Advanced Low Power VLSI and Mixed-signal IC Design</td>
</tr>
<tr>
<td>COMP_ENG 459-0</td>
<td>VLSI Algorithmics</td>
</tr>
<tr>
<td>COMP_ENG 493-0</td>
<td>Advanced Low Power VLSI and Mixed-signal IC Design</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_ENG 312-0</td>
<td>Introduction to Robotics</td>
</tr>
<tr>
<td>COMP_ENG 321-0</td>
<td>Programming Languages</td>
</tr>
<tr>
<td>COMP_ENG 322-0</td>
<td>Compiler Construction</td>
</tr>
<tr>
<td>COMP_ENG 323-0</td>
<td>Code Analysis and Transformation</td>
</tr>
<tr>
<td>GEN_ENG 519-0</td>
<td>Responsible Conduct for Research Training</td>
</tr>
<tr>
<td>COMP_ENG 339-0</td>
<td>Introduction to Database Systems</td>
</tr>
<tr>
<td>COMP_ENG 340-0</td>
<td>Introduction to Networking</td>
</tr>
<tr>
<td>COMP_ENG 343-0</td>
<td>Operating Systems</td>
</tr>
<tr>
<td>COMP_ENG 351-1</td>
<td>Introduction to Computer Graphics</td>
</tr>
<tr>
<td>COMP_ENG 354-0</td>
<td>Network Penetration &amp; Security</td>
</tr>
<tr>
<td>COMP_ENG 446-0</td>
<td>Kernel and Other Low-level Software Development</td>
</tr>
<tr>
<td>COMP_ENG 455-0</td>
<td>Distributed Computing Systems</td>
</tr>
</tbody>
</table>

## Track A. Digital Design & VLSI

<table>
<thead>
<tr>
<th>Course</th>
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</tr>
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<tbody>
<tr>
<td>COMP_ENG 303-0</td>
<td>Advanced Digital Design</td>
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<tr>
<td>COMP_ENG 355-0</td>
<td>ASIC and FPGA Design</td>
</tr>
<tr>
<td>COMP_ENG 357-0</td>
<td>Design Automation in VLSI</td>
</tr>
<tr>
<td>COMP_ENG 391-0</td>
<td>CMOS VLSI Circuit Design</td>
</tr>
<tr>
<td>COMP_ENG 393-0</td>
<td>Advanced Low Power VLSI and Mixed-signal IC Design</td>
</tr>
<tr>
<td>COMP_ENG 459-0</td>
<td>VLSI Algorithmics</td>
</tr>
<tr>
<td>COMP_ENG 493-0</td>
<td>Advanced Low Power VLSI and Mixed-signal IC Design</td>
</tr>
</tbody>
</table>

## Track B. Embedded Systems

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_ENG 346-0</td>
<td>Microprocessor System Design</td>
</tr>
<tr>
<td>COMP_ENG 364-0</td>
<td>CyberPhysical Systems Design and Application</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_ENG 365-0</td>
<td>Internet-of-things Sensors, Systems, And Applications</td>
</tr>
</tbody>
</table>
Other PhD Degree Requirements
• Teaching Requirement
• Admission to PhD Candidacy through coursework or oral qualifier examination
• Prospectus Examination
• Dissertation and Defense

Additional requirements and processes are detailed in the Computer Engineering Graduate Study Guide (https://www.mccormick.northwestern.edu/electrical-computer/graduate/phd/requirements.html) and The Graduate School Policy Guide (p. 7).

Computer Science and Learning Sciences
https://csls.sesp.northwestern.edu/

Degree Types: PhD

The Joint PhD Program in Computer Science and Learning Sciences builds on enduring and growing connections between research on learning and computation. Rapid technological advances continue to create new and exciting ways to both understand and support learning in all settings and in all stages of life. This program is intended for students with an interest in both fields who would otherwise be forced to choose one area or the other.

Areas of Interest
The possible areas of study are broad and draw from the diverse expertise of affiliated faculty. However, all research must have clear relevance to both Computer Science and Learning Sciences. Example areas of interest include educational data mining; computational modeling as a means to understand complex scientific phenomena; adaptive technology for learning; equity issues in computing; intelligent tutoring systems; and interaction design to support learning.

Degrees Offered
• Computer Science and Learning Sciences PhD (p. 49)

Computer Science and Learning Sciences PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Course Requirements
Students are expected to take courses during the first two years of their graduate career. Every student is required to take courses that fulfill specific requirements for breadth and depth in computer science and learning sciences. Students are also expected to take coursework and continue reading beyond these specific requirements. In particular, students should take coursework that is relevant to their research.

Learning Sciences Foundational Courses (4 courses)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRN_SCI 401-0</td>
<td>Knowledge Representation for the Learning Sciences</td>
</tr>
<tr>
<td>or COMP_SCI 371-0</td>
<td>Knowledge Representation and Reasoning</td>
</tr>
<tr>
<td>LRN_SCI 402-0</td>
<td>Social Dimensions of Teaching &amp; Learning</td>
</tr>
<tr>
<td>LRN_SCI 403-0</td>
<td>Foundations of the Learning Science</td>
</tr>
<tr>
<td>LRN_SCI 426-0</td>
<td>Design of Technological Tools for Thinking and Learning</td>
</tr>
</tbody>
</table>

Learning Sciences Approved Methods Courses (choose 3 courses)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRN_SCI 410-0</td>
<td>Quantitative Methods I: Probability and Statistics</td>
</tr>
<tr>
<td>LRN_SCI 451-0</td>
<td>Topics in Learning Sciences (Quantitative Methods II regression analysis)</td>
</tr>
<tr>
<td>LRN_SCI 451-0</td>
<td>Topics in Learning Sciences (Discourse Analysis)</td>
</tr>
<tr>
<td>LRN_SCI 415-0</td>
<td>Field Methods</td>
</tr>
<tr>
<td>LRN_SCI 416-0</td>
<td>Advanced Qualitative Methods</td>
</tr>
<tr>
<td>LRN_SCI 451-0</td>
<td>Topics in Learning Sciences (Computational Methods)</td>
</tr>
<tr>
<td>COMP_SCI 472-0/ LRN_SCI 451-0</td>
<td>Designing &amp; Constructing Models with Multi-Agent Language</td>
</tr>
</tbody>
</table>

Computer Science Foundational Courses (at least 5 courses)

Students will declare a Computer Science concentration (e.g., Graphics and Interactive Media or Cognitive Systems). Students should take at least 5 courses in CS that are approved for graduate credit (all 300 and 400-level courses, unless specifically listed as ineligible for graduate credit). Students should consult the qualifying procedures for their program to ensure they have the necessary background for their concentration. The requirements for GIM and CogSys are listed below for reference:

Graphics and Interactive Media (GIM)
All GIM students are required to demonstrate proficiency in computer science and other core fields of GIM:

• Programming (comparable to CS 111+211+311)
• Theory
  • Fundamental algorithms
  • Computing and complexity theory
• Systems (2 of the following)
  • Operating systems
  • Computer architecture
  • Networking
• Programming languages
• Graphics or media
• Cognitive and social systems (any course in AI, cognitive science, social science)

Cognitive Systems (CogSys)
By the Qualifying Exam, you should be conversant with the material in the following courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_SCI 325-1</td>
<td>Artificial Intelligence Programming</td>
</tr>
<tr>
<td>COMP_SCI 337-0</td>
<td>Natural Language Processing</td>
</tr>
<tr>
<td>COMP_SCI 338-0</td>
<td>Practicum in Intelligent Information Systems</td>
</tr>
<tr>
<td>COMP_SCI 344-0</td>
<td>Design of Computer Problem Solvers</td>
</tr>
<tr>
<td>COMP_SCI 348-0</td>
<td>Introduction to Artificial Intelligence</td>
</tr>
</tbody>
</table>
Breadth Courses (3 courses)
Three additional courses are required within years 2 and 3. Any non-required, graduate-level course in any school or department can be used to fulfill the breadth requirement.

Other Degree Requirements
- Second-year qualifying exams
- Second-year independent research project
- PhD Dissertation

Computer Science
https://mccormick.northwestern.edu/computer-science/

Degree Types: MS, PhD

The Department of Computer Science (https://www.mccormick.northwestern.edu/computer-science/graduate) offers programs leading to the MS and PhD degrees in Computer Science (CS) and in Computer Engineering (https://www.mccormick.northwestern.edu/electrical-computer/graduate) (CE).

The department also participates in other graduate programs on campus. For details and contact information, see the respective web sites for each program:
- Master's Program in Information Technology (https://www.mccormick.northwestern.edu/information-technology)
- MA and PhD Programs in the Learning Sciences (https://www.sesp.northwestern.edu/learning-sciences)
- Cognitive Science Program (https://www.cogsci.northwestern.edu)
- PhD program in Technology and Social Behavior (http://tsb.northwestern.edu)

Degrees Offered
- Computer Science MS (p. 50)
- Computer Science PhD (p. 50)
- Computer Engineering MS (p. 46)
- Computer Engineering PhD (p. 48)

Computer Science MS
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's
Total Units Required: 12

Each student pursuing an MS degree in the Computer Science Department must declare their intention on the Graduate Student Tracking System (https://gsts.northwestern.edu/site/login) (GSTS) to follow one of these three plans:

a) Thesis MS Degree, or
b) Project MS Degree, or
c) Course MS Degree.

The three options are summarized below. The student's declaration is subject to approval by their adviser. We recommend that this declaration be made during the second (winter) quarter, but we require that it be made no later than May 1st of the third (spring) academic quarter.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twelve (12) units of graduate-level credits are required for any CS MS degree</td>
<td></td>
</tr>
<tr>
<td>At least six (6) units must be graduate-level COMP_SCI courses</td>
<td></td>
</tr>
<tr>
<td>At least three (3) of the 12 units must be courses at 400-level or above</td>
<td></td>
</tr>
<tr>
<td>Comp_Sci 499 counts towards this requirement, Comp_Sci 590 does not</td>
<td></td>
</tr>
</tbody>
</table>

Plan A: Thesis MS Degree
Total Units Required: 12

In this plan, a student declares their intent to earn the MS degree by completing a formal thesis that reports substantial original research results. A maximum of three units of COMP_SCI 590 research credit can be counted toward the 12-unit requirement for the Thesis MS degree. Successful completion of this degree includes all coursework, formation of, and reporting by, an MS Examination Committee, and written approval of the student's completed thesis by that committee.

Plan B: Project MS Degree
Total Units Required: 12

In this plan, a student declares their intent to earn the MS degree by completing a project and writing a project report that contains results based on existing theory and techniques, or results of a significant experimental verification. A maximum of two units of COMP_SCI 590 research credit can be counted toward the 12-unit requirement for the MS Project degree. Successful completion of this degree includes all coursework, formation of, and reporting by, an MS Examination Committee, and written approval of the student's completed project report by that committee.

Plan C: Courses-only MS Degree
Total Units Required: 12

In this plan, a student must satisfactorily complete 12-courses approved by the student’s adviser. The choice of courses must represent a coherent program of study, and must prepare the student for advanced work in a specific field selected in coordination with the adviser.

Computer Science PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: 15

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 graded units of graduate coursework for the PhD</td>
<td></td>
</tr>
<tr>
<td>Coursework includes COMP_SCI 499, but not COMP_SCI 590 (Research)</td>
<td></td>
</tr>
<tr>
<td>Six (6) units should be at the 400-level or above</td>
<td></td>
</tr>
<tr>
<td>Not counting COMP_SCI 545 and COMP_SCI 546 (the two credits PhD students can earn for teaching)</td>
<td></td>
</tr>
</tbody>
</table>
The normal full-time course load is three units and maximum is four units per academic quarter. All students receiving financial aid (fellowships, assistantships, grants, etc.) must register as full-time students.

Other PhD Degree Requirements
- **Dissertation Adviser**: PhD students are required to obtain a permanent faculty advisor by the end of their third quarter (typically spring quarter). The advisor, who must have a primary academic appointment in the Computer Science department, or an active and current courtesy appointment, must formally notify the CS department and supply an approved funding plan for the student.
- **Research**: independent research leading to dissertation; research is begun by third quarter of first year or sooner, continuing through summer into second year
- **Teaching**: at least two experiences as instructor, teaching assistant, or teaching trainee
- **Examinations**: Prospectus, Oral Thesis Defense, and Written Dissertation vary by research group as described in the CS Graduate Study Manual but must follow the timelines set by The Graduate School.

**Counseling**
https://www.family-institute.org/graduate-education/master-arts-counseling

https://counseling.northwestern.edu/

Degree Type: Master of Arts

Northwestern University’s nationally-renowned Master of Arts in Clinical Mental Health Counseling, with sites on-ground and online, is dedicated to the cutting edge preparation of tomorrow’s counselors and stands on several pillars of excellence.

- **The Dynamic Clinical Training Model of The Family Institute at Northwestern University** – The Family Institute (TFI) is a world-renown organization that has integrated education, clinical services and mental health research for decades. In TFI’s approach, students are educated in mental health practice and apply their skills with real clients. Students work under the supervision of seasoned practitioners, who are themselves leading the way in conducting counseling and psychotherapy. TFI sets a high standard in innovative scholarship, teaching and practice and this drives our students to make rapid gains in therapeutic knowledge and skill development.
- **The Counseling Profession** – Influenced by the theoretical and intellectual traditions of the Counseling field, our students are prepared to protect the mental health and wellness of those who use counseling services. Students complete education and supervised clinical experiences required by the Council for Accreditation of Counseling and Related Educational Programs (CACREP), the body that accredits our program. We conceptualize coursework in the context of ethics, multiculturalism, lifespan development, advocacy and outreach, and evidenced-based practice. These traditions lead to the development of a strong counselor identity and prepare students to seek licensure across the United States.
- **The Program’s Historical Foundation** – Our program grew out of a doctoral program in Counseling Psychology and the intensity and rigor of advanced education is still embedded in our pedagogy and training. Students explore the depth and complexities of the psychoanalytic perspective and its emphasis on the centrality of the therapeutic relationship and the importance of therapist self-reflection. Simultaneously, students delve into research and other scholarship, culminating in their own CAPSTONE that intermingle the program’s rich academics with current best practices in the field. In CAPSTONE students become informed consumers who not only understand the research base of the profession, but help expand it with new ideas. Students also readily showcase their ideas about mental health and wellness through conference presentations and academic publications. We take pride in our clinicians-in-training who have an aptitude to generate future scholarship that will advance the field of counseling.

**Our Program’s Vision**
We are leaders in preparing psycho-dynamically-informed, culturally responsive, clinical mental health counselors to promote the mental health and wellness of people.

**Our Program’s Mission**
Our mission is to deliver innovative, clinical mental health counselor training that is grounded in contemporary psychodynamic theory, best practices from multiple perspectives, and a multicultural worldview, preparing students to become competent counselors, mental health advocates and leaders nationwide.

**Program Objectives**
Students will:
1. Possess an in-depth understanding of Clinical Mental Health Counseling that integrates psychodynamic and emerging best practices
2. Demonstrate self-reflective, counseling skills honed through extensive and closely supervised clinical work
3. Demonstrate rich multicultural awareness that embraces and advances diversity and social justice values
4. Embody a professional counselor identity
5. Showcase a scientific mindset, interest in scholarship and profession-centered activities

**The Essence of Our Vision, Mission and Objectives**
Our psychodynamic foundations influence cornerstone education and training experiences to facilitate counselor development. The psychodynamic flavor of the program encourages student self-exploration and acknowledgment of the forces outside of awareness, often rooted in the past, that can exert profound influences on identity, values and experiences. We train students to become aware of how their past, as well as their clients’, dynamically affect their present lives. The goal is to liberate the shackles of the past for a more enriching, authentic life in the present. To amplify the psychodynamic lens our program emphasizes two core experiences: Reflective Practice, Comprehensive Immersion in Multiculturally Competent Clinical Work.

**Emphasis on Reflective Practice**
While academic coursework is integrated and therapeutically potent skills are emerging, we offer opportunities to reflect on the training experience in a supportive environment. It is here that students’ own personal and professional strengths and struggles are examined, barriers to learning are identified, and strategies for navigating the training process are
developed. Three powerful reflective experiences provide building blocks to this training foundation.

- **Reflective Practitioner Supervision (RPS)**: During the Practicum experience, students meet weekly in small groups with a seasoned practitioner, where the training process is viewed through a psychodynamic lens. Students examine their emerging therapeutic skills, during this experience in order to separate what is a therapeutically powerful tool for them from what needs to be sharpened. RPS also focuses on understanding client transference and therapist countertransference, identifying biases that affect therapeutic objectivity, and removing personal barriers to staying fully present with the client. Students are also encouraged to becoming highly aware of their own social and cultural identities, power and privilege to pave the way for cross-culturally proficient work with clients.

- **Case Conference Supervision (CCS)**: During the Internship experience, students meet weekly with a seasoned practitioner to present challenging cases and receive consultation that integrate psychodynamic and multicultural perspectives. Here our rich coursework comes alive as it is applied to facilitate students’ engagement in the therapeutic process. Through the exploration of challenging or difficult cases, students learn how to assess their therapeutic effectiveness and articulate areas of concern that can be addressed in consultation in order to increase efficacy.

- **Group Relations Immersion**: During Practicum students participate in Tavistock (on-campus) or Group Dynamics Immersion (online), both on the Evanston campus. Group relations immersion is a three-day group experience guided by teams of seasoned practitioners. The group relations immersion is a living laboratory in which students experience and examine group, institutional and diversity dynamics. Embedded in our Group Dynamics course, the immersion generates powerful experiential learning. Learning from the group relations immersion reverberates throughout students’ time in the program, as knowledge of the unconscious and covert processes, and inter- and intra-personal dynamics active in groups and organizations, are applied to the students’ work with clients.

**Comprehensive Immersion in Clinical Work**

From the moment students enter the program, they are immersed in clinical work. The “learning-by-doing” approach exposes students to clinical practice while providing complementary academic experiences. At each stage in their development as counselor, students are equipped with the necessary clinical skills and knowledge. We cater to students entering the counseling field with academic and experiential background in psychology or human services and prior clinical experiences and we also offer a program designed for students entering the counseling field for the first time following a career in another discipline and/or with minimal academic and experiential background in psychology or human services.

- In the practicum training year students spend 16-20 hours per week immersed in clinical work. They complete a minimum of 50 hours of face-to-face counseling and receive close to 100 hours of group and individual supervision. Additionally, students meet weekly in Reflective Practitioner Supervisor groups and participate in the Group Dynamics Immersion.
- In the internship year, students spend 20-24 hours per week at a clinical field site. They complete a 600 hour internship experience with a minimum of 240 hours of face-to-face counseling and spend a minimum of 85 hours in clinical supervision and the Case Conference Supervision. To the extent possible, the internship placement is tailored to the student’s choice of specialization. Students often draw on clinical training to formulate their CAPSTONE project.

**Degrees Offered**

Counseling MA (p. 52)

**Counseling MA Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

**Total Units Required On-ground: Standard Curriculum 24 units, Two-Plus Curriculum 27 units**

**Total Units Required Online: Standard Curriculum 24 units, Bridge Curriculum 27 Units**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUN 406-0</td>
<td>Research Methods in Counseling</td>
</tr>
<tr>
<td>COUN 406-6</td>
<td>Research Methods in Counseling</td>
</tr>
<tr>
<td>COUN 411-0</td>
<td>Individuals &amp; Systems: Psychodynamic Viewpoints</td>
</tr>
<tr>
<td>COUN 411-6</td>
<td>Psychodynamic Counseling (On-ground: Individuals and Systems)</td>
</tr>
<tr>
<td>COUN 412-0</td>
<td>Theories &amp; Techniques of Group dynamics</td>
</tr>
<tr>
<td>COUN 412-6</td>
<td>Theories &amp; Techniques of Group dynamics</td>
</tr>
<tr>
<td>COUN 413-6</td>
<td>Human Development (Child)</td>
</tr>
<tr>
<td>COUN 414-0</td>
<td>Human Growth and Development</td>
</tr>
<tr>
<td>COUN 414-6</td>
<td>Human Development (Adult)</td>
</tr>
<tr>
<td>COUN 415-0</td>
<td>Psychopathology in Counseling</td>
</tr>
<tr>
<td>COUN 415-6</td>
<td>Psychopathology in Counseling</td>
</tr>
<tr>
<td>COUN 416-0</td>
<td>Theories of Counseling &amp; Psychotherapy</td>
</tr>
<tr>
<td>COUN 416-6</td>
<td>Theories of Counseling &amp; Psychotherapy</td>
</tr>
<tr>
<td>COUN 417-0</td>
<td>Cognitive Behavioral Therapy</td>
</tr>
<tr>
<td>COUN 417-6</td>
<td>Cognitive Behavioral Therapy</td>
</tr>
<tr>
<td>COUN 418-0</td>
<td>Psychodynamic Counseling</td>
</tr>
<tr>
<td>COUN 419-0</td>
<td>Contemporary Issues in Career Counseling</td>
</tr>
<tr>
<td>COUN 422-0</td>
<td>Foundations of Family, Marital and Couples Counseling</td>
</tr>
<tr>
<td>COUN 422-6</td>
<td>Foundations of Family, Marital and Couples Counseling</td>
</tr>
<tr>
<td>COUN 425-0</td>
<td>Improving Methods and Practices in Psychological Science: The Replication Crisis and Beyond</td>
</tr>
<tr>
<td>COUN 426-0</td>
<td>Assessment in Counseling</td>
</tr>
<tr>
<td>COUN 426-6</td>
<td>Assessment in Counseling</td>
</tr>
<tr>
<td>COUN 427-0</td>
<td>Career Development</td>
</tr>
<tr>
<td>COUN 427-6</td>
<td>Career Development</td>
</tr>
<tr>
<td>COUN 429-6</td>
<td>Sexuality in Counseling</td>
</tr>
<tr>
<td>COUN 430-0</td>
<td>Vocational Assessment in Counseling</td>
</tr>
<tr>
<td>COUN 436-0</td>
<td>COUN 436-0 Child &amp; Adolescent Counseling and Psychotherapy (1 Unit)</td>
</tr>
<tr>
<td>COUN 436-6</td>
<td>Child &amp; Adolescent Counseling and Psychotherapy</td>
</tr>
<tr>
<td>COUN 451-0</td>
<td>Topics in Counseling</td>
</tr>
<tr>
<td>COUN 452-0</td>
<td>Theory &amp; Technique of Substance Abuse Counseling</td>
</tr>
<tr>
<td>COUN 452-6</td>
<td>Theory &amp; Technique of Substance Abuse Counseling</td>
</tr>
</tbody>
</table>
## Course Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGLISH 403-0</td>
<td>Writers’ Studies in Literature (three seminars)</td>
</tr>
<tr>
<td>ENGLISH 493-0</td>
<td>Elements of Craft (first year; a guided writing workshop)</td>
</tr>
<tr>
<td>ENGLISH 494-0</td>
<td>Mapping the MFA Thesis (second year; a guided writing workshop)</td>
</tr>
</tbody>
</table>

- Five 400-level seminars in English
- One additional literature or theory course at the 300- or 400-level, in English or another department or program.

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide.

### Degrees Offered

- Litowitz Creative Writing Graduate Program MFA+MA (p. 53)

## Litowitz Creative Writing Graduate Program MFA+MA

Degree Types: MFA+MA

This new, fully-funded MFA+MA in Creative Writing and English program offers intimate classes, the opportunity to pursue both creative and critical writing, and close mentorship by renowned faculty in poetry, fiction, and creative nonfiction. Our three-year curriculum gives students time to deepen both their creative writing and their study of literature. Students will receive support for three academic years, and two summers, to complete both degrees — an MFA in Creative Writing and an MA in English.

Drawing on innovative scholarship, deep immersion in process, and cross-pollination between critical and creative texts, students will complete book-length thesis projects of their own design, either within or across genres, and a substantial essay on literary texts. The program’s small size and attentive faculty will develop students’ sense of literary context, while encouraging them to pursue the distinctiveness of their projects.

In addition to their studies, students will be guided in the teaching of creative writing and, through summer editorial work at TriQuarterly.org, the editing of a literary journal.

Students will pursue their work on our beautiful Evanston campus, amid artists, filmmakers, scholars and public intellectuals, with easy access to the vibrant literary arts scene of Chicago.

### Course Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGLISH 495-0</td>
<td>Cross-Genre Creative Writing Workshop</td>
</tr>
<tr>
<td>ENGLISH 496-0</td>
<td>MFA Poetry Workshop</td>
</tr>
<tr>
<td>ENGLISH 497-0</td>
<td>MFA Fiction Workshop</td>
</tr>
<tr>
<td>ENGLISH 498-0</td>
<td>MFA Creative Nonfiction Workshop</td>
</tr>
<tr>
<td>ENGLISH 571-0</td>
<td>Teaching Creative Writing (first year)</td>
</tr>
<tr>
<td>ENGLISH 491-0</td>
<td>Editorial Practicum (two quarters, summers, noncredit)</td>
</tr>
<tr>
<td>ENGLISH 490-0</td>
<td>Independent Reading (three quarters, when working as a TA)</td>
</tr>
<tr>
<td>ENGLISH 591-0</td>
<td>MFA Thesis Tutorial (three quarters, in third year)</td>
</tr>
</tbody>
</table>
The Department of Theater also offers a PhD Program in Theater and Drama. The curriculum is designed to acquaint the student with a wide variety of literary and theatrical styles, text analysis, period research, and collaboration skills. In addition, design students participate in seminars to study text analysis, period research, and collaboration skills. The collaboration between designer and director is central to this study and results in produced and theoretical theater work.

The program leading to the MFA in Directing trains stage directors to possess strong practical knowledge of theater practice and to demonstrate an understanding of a range of storytelling styles and practices in the theater. The curriculum is designed to acquaint the student with a wide variety of literary and theatrical styles, text interpretation, working knowledge of stage design, and basic and advanced directing theory and practice. The director will work on collaboration techniques with designers in classroom and production activities. Assistantships with professional theaters in and out of Chicago provide additional training and professional connections. Understanding of the collaborative process involved in directing individual artistic skills toward a shared vision of a theatrical experience is of central importance in the curriculum.

The Department of Theater also offers a PhD Program in Theater and Drama (https://www.tgs.northwestern.edu/academics/programs/theater-drama).

**Degrees Offered**
- Directing MFA (p. 54)

**Directing MFA**

**Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

**Total Units Required: 27**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>THEATRE 402-0</td>
<td>Graduate Colloquium</td>
</tr>
<tr>
<td>THEATRE 312-0</td>
<td>Text Analysis</td>
</tr>
<tr>
<td>THEATRE 310-0</td>
<td>Special Topics in Directing</td>
</tr>
<tr>
<td>THEATRE 313-0</td>
<td>History of Directing</td>
</tr>
<tr>
<td>THEATRE 342-0</td>
<td>Dramaturgy</td>
</tr>
<tr>
<td>THEATRE 420-1</td>
<td>Collaboration: American Realism</td>
</tr>
<tr>
<td>&amp; THEATRE 420-2</td>
<td>and Collaboration: Contemporary Drama</td>
</tr>
<tr>
<td>&amp; THEATRE 420-3</td>
<td>and Collaboration: Shakespeare in the 21st Century</td>
</tr>
<tr>
<td>THEATRE 450-0</td>
<td>Topics in Stage Design</td>
</tr>
<tr>
<td>THEATRE 451-1</td>
<td>Seminar in Advanced Directing</td>
</tr>
<tr>
<td>&amp; THEATRE 451-2</td>
<td>and Seminar in Advanced Directing</td>
</tr>
<tr>
<td>&amp; THEATRE 451-3</td>
<td>and Seminar in Advanced Directing</td>
</tr>
<tr>
<td>THEATRE 546-0</td>
<td>Seminar-Studies in Theatre</td>
</tr>
<tr>
<td>THEATRE 590-0</td>
<td>Research</td>
</tr>
</tbody>
</table>

Electives chosen from available offerings in School of Communication, Bienen School of Music, and Weinberg College of Arts and Sciences (14 units)

**Other MFA in Directing Degree Requirements**
- **Examinations:** annual faculty evaluation
- **Research/Projects:** three project productions
- **Master of Fine Arts Thesis:** written thesis
- **Other:** oral defense of thesis

**Documentary Media**

https://docmedia.northwestern.edu/

**Degree Types:** MFA

The Master of Fine Arts in Documentary Media (https://docmedia.northwestern.edu) is a professional degree that provides students with the knowledge and skills needed to create compelling documentaries and other kinds of media using documentary methods.

This program encourages connectivity across disciplines, formats, and genres. It equips students with a diverse set of skills to tell meaningful stories and pursue creative and professional opportunities.

Participants will make traditional documentaries, apply narrative techniques to documentary forms, and apply documentary techniques to narrative or emergent media projects. Over the course of this two-year program, students will learn, work and grow together to form a close-knit artistic community.

**Degrees Offered**
- Documentary Media MFA (p. 55)
Documentary Media MFA

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Program requirements include:

- Eighteen credit units of study, maintaining at least a B average. A mid-program review at the end of the first year will be used to determine whether students can continue to the second year of study. Students failing to meet the requirement of a B average will not be permitted to progress to the second year.
- An MFA Portfolio containing:
  - 20-45 minutes of edited material or 2-3 interactive projects, including the 12-20 minute or interactive thesis project.
  - A written artist statement regarding: how submitted works are connected; who applicant is as a developing artist; what applicant hopes to accomplish, creatively and professionally, through continued work in the field; why applicant thinks their work will make an important and significant contribution to the field.
  - A distribution plan for getting their completed films/interactive thesis project distributed/displayed and for "getting to the next level" professionally as an artist
- Completion of all thesis requirements and successful defense of the MFA thesis project before a faculty committee.

Coursework Requirements

Total Units Required: 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses (6 units)</td>
<td></td>
</tr>
<tr>
<td>RTVF 551-0</td>
<td>Documentary Techniques</td>
</tr>
<tr>
<td>RTVF 552-0</td>
<td>Narrative Techniques</td>
</tr>
<tr>
<td>RTVF 553-0</td>
<td>Interactive Techniques/Emerging Forms</td>
</tr>
<tr>
<td>RTVF 554-0</td>
<td>Thesis 1</td>
</tr>
<tr>
<td>RTVF 555-0</td>
<td>Thesis 2</td>
</tr>
<tr>
<td>RTVF 556-0</td>
<td>Thesis 3</td>
</tr>
<tr>
<td>Topics Courses (5 units)</td>
<td></td>
</tr>
</tbody>
</table>
| RTVF (300 level or higher) with director of MFA approval | Sample courses include:
|                          | Editing; Lighting Cinematography; SFX Cinematography; Designing for the Internet; Directing Actors; Producing; Advanced Audio Production; Advanced Sound Design; Color Correction; 2D Computer Animation; 3D Computer Animation; Stop Motion Animation; Animated Infographics; Interactive Comics; Conceptual Design; Advanced SFX Recording; Approaches to Video Game Design; Gaming Narratives; Experimental Media Production; Place Based Documentary; Problem Families/Family Problems; Secrets and Lies; Computer Code as Expressive Medium; Layout and Storyboarding; Sitcom Production; Romantic Comedy; Rebels, Misfits, and Losers; Making the Bromance; Making Reality TV; Love Hurts; Romantic Triangles; Websodes |
| Theory/history/culture Courses (1 unit) | (300-level or higher) |
|                          | From Production, Screen Cultures, or Writing/RTVF, Performance Studies, Art Theory and Practice, Theatre, or other departments with approval of MFA program director. A course in the area of nonfiction media, documentary history/theory, or reality television is especially encouraged. |
| Electives (5 units)      |                                            |

Other MFA Degree Requirements

MFA students will be allowed to take a maximum of 20 credits.

- **Grade average:** you must maintain a B average. If your average is not a B or higher by the end of the first year, you may be asked to leave the program.
- **First Year Review:** The academic and professional progress of all first year MFAs will be reviewed in early June by the director of the program in consultation with production faculty. If weaknesses are identified, a formal interview with that student will be conducted by the director and production faculty to determine an appropriate course of action. Subsequent to that interview, at the discretion of the director, the grade for the spring core 500-level production seminar may be used to determine whether that student will be allowed to continue in the program, with a grade of C+ or below resulting in possible removal.
- **Final Portfolio Review/Defense:** In consultation with the director of the program, you will choose a committee of two faculty members (both part of the Graduate School faculty) to review your final portfolio (20-45 minutes of edited material or 2-3 interactive projects created in classes -- including the 12-20 minute or interactive thesis project) and to assess your final defense of that portfolio, which will include a written artist statement and business plan.

Driskill Graduate Training Program in Life Sciences

https://www.feinberg.northwestern.edu/sites/dgp/index.html

Degree Types: PhD

The Walter S. and Lucienne Driskill Graduate Training Program in Life Sciences (https://www.feinberg.northwestern.edu/sites/dgp) (DGP) combines graduate study in biochemistry and structural biology, cancer biology, cell biology, developmental biology, genetics and genomics, immunology, microbiology, neurobiology, pharmacology, systems biology, and biomedical informatics into a single program. More than 140 faculty members are available as dissertation research advisors, and their interests cover a wide range of research in contemporary biomedical and life sciences.

The DGP provides each student the flexibility needed to design a personal course of study, pursue individual research interests, and choose an appropriate thesis advisor. The wide range of research opportunities within the DGP serves students well - both those who enter graduate school committed to a specific research field and those who begin with many potential interests. Flexibility and ease in pursuing diverse interests are the hallmarks of graduate training in the DGP.
Degrees Offered

- Driskill Graduate Training Program in Life Sciences PhD (p. 56)
- Life Sciences and Clinical Investigation Dual Degree MS/PhD (p. 76)
- Life Sciences and Public Health Dual Degree PhD/MPH (p. 77)

Driskill Graduate Training Program in Life Sciences PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's

The DGP is a PhD training program; however, there are situations when pursuit of the PhD cannot be completed and therefore an option for a terminal master's degree is provided. This degree option is not used for recruiting or admission purposes. A student seeking this degree, in addition to having successfully completed all required courses and having passed the Qualifying Exam, must have:

1. completed the thesis proposal process successfully;
2. held at least one annual thesis committee meeting after the thesis proposal;
3. completed sufficient research towards their PhD to write a master's thesis.

PhD students in good academic standing who wish to obtain a terminal master's degree will petition the DGP Program Committee and the Director of the DGP explaining why they cannot complete the PhD program. The Program Committee would consider both the nature of the circumstances as well as the quality of the research in determining whether the student should be allowed to write a thesis and obtain the master's degree. Permission to pursue the degree will only be granted to those students whose body of research could reasonably result in a thesis. Students who are granted permission will submit a master's degree thesis to a committee comprised of members of their original PhD thesis committee and an ex officio member from the Program Committee. An oral defense will also be required. The committee will determine whether the written document and oral defense are sufficient to warrant the degree. There is no publication requirement.

PhD

Total Units Required: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Courses</strong></td>
<td></td>
</tr>
<tr>
<td>Core Courses (Biochemistry, Molecular Biology, Cell Biology, Statistics; 4 units)</td>
<td></td>
</tr>
<tr>
<td>Elective courses (4 units)</td>
<td></td>
</tr>
<tr>
<td>Lab Rotations (1 unit)</td>
<td></td>
</tr>
<tr>
<td><strong>Noncredit Required Courses (2 courses required)</strong></td>
<td></td>
</tr>
<tr>
<td>IGP 494-0</td>
<td>Colloquium on Integrity in Biomedical Research</td>
</tr>
<tr>
<td>IGP 496-1</td>
<td>Introduction to Life Science Research</td>
</tr>
</tbody>
</table>

Other PhD Degree Requirements

- **Examinations**: qualifying examinations during second year of study.
- **Research/Projects**: laboratory research based on dissertation research proposal
- **Thesis prospectus**: written thesis proposal and presentation to thesis committee in fall of second year.
- **PhD Dissertation**: written dissertation; annual presentation of research-in-progress to Thesis Committee
- **Final Evaluations**: dissertation defense consisting of written dissertation, public presentation of research accomplishments and oral defense of dissertation to Thesis Committee
- **Publication**: of a portion of thesis work in a peer-reviewed journal
- **Teaching**: one quarter as a teaching assistant
- **Other**: three laboratory rotations in first year, intended to assist student in selecting dissertation research advisors; regular participation in seminars and journal clubs; teaching assignment one quarter in third year

Earth and Planetary Sciences

https://www.earth.northwestern.edu/

Degree Types: PhD

The Earth and Planetary Sciences (EPS) PhD Program (https://www.earth.northwestern.edu/graduate) trains graduate students for careers in- and outside of academia.

- The program is disciplinarily and methodologically diverse, and provides state-of-the-art facilities, including analytical, experimental, and computational laboratories. Faculty expertise spans climate science and modeling, geobiology, microbial ecology, paleoclimate, paleolimnology, paleoceanography, sedimentary geology, stratigraphy, mineral physics, aqueous and isotope geochemistry, geophysics, seismology, petrology, and tectonics.
- The department's size fosters individualized attention, strong professional bonds, and diverse opportunities for participation in field work and working with more than one faculty advisor. Within their first quarter, entering students develop research projects and individualized training programs with their research advisor of choice.
- Students who have majored in a natural science like biology, physics, or chemistry, or in engineering or an affiliated STEM discipline are equally welcome as Earth science graduates and will be provided opportunities to acquire a background in Earth and planetary sciences.

PhD level research stresses the development of new principles, concepts, and discoveries.

Degrees Offered

- Earth and Planetary Sciences PhD (p. 56)

Earth and Planetary Sciences PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 16

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Courses</strong></td>
<td></td>
</tr>
<tr>
<td>Earth and planetary sciences (300-level; 6 units)</td>
<td></td>
</tr>
</tbody>
</table>
Mathematics, physics, chemistry, or engineering (300- or 400-level; differential equations; 2 units)
Earth and planetary sciences, other sciences, or engineering, including independent study (8 units) \(^1\)

\(^1\) may include CHEM 342-1 Thermodynamics

Other PhD Degree Requirements
- **Examinations:** qualifying examination for admission to candidacy, ordinarily taken during second year (when students usually select dissertation topic and research supervisor)
- **Research/Projects:** none specified
- **PhD Dissertation:** original, independent research
- **Final Evaluations:** examination dealing primarily with dissertation

Economics
https://www.economics.northwestern.edu/

Degree Types: MA, PhD

The PhD Program in Economics (https://www.economics.northwestern.edu/graduate) prepares students for careers in college teaching and research, government and international agencies, or private business. The curriculum covers all principal areas of economic study and research.

Advanced courses, seminars, and research opportunities are offered in the fields of applied microeconomics, development economics, econometrics, economic history, economic theory, industrial organization, international economics, labor economics, macroeconomics, and public finance. Weekly workshops provide a forum for faculty, students, and distinguished economists from around the world to meet and present their research.

The PhD program in Economics shares courses, faculty, and seminars with Kellogg School of Management (https://www.kellogg.northwestern.edu) doctoral programs in Finance (p. 63) and Managerial Economics and Strategy (p. 80).

The Department and the Finance Department of the Kellogg School of Management jointly offer a combined PhD in Financial Economics (p. 64).

The Department does not normally admit students for a terminal MA degree. An MA degree is only available to Economics PhD students who have successfully completed the first year of the doctoral program, to students enrolled in other doctoral programs at Northwestern, and to undergraduate students who are completing a combined BA/MA degree.

Degrees Offered
- Economics MA (p. 57)
- Economics PhD (p. 58)

Economics Masters

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

The department does not normally admit students for a terminal MA degree.

Economics and Financial Economics PhD Students

Doctoral students in the Economics and Financial Economics PhD programs who complete ECON 410-1 Microeconomics, ECON 410-2 Microeconomics, ECON 410-3 Microeconomics, ECON 411-1 Macroeconomics, ECON 411-2 Macroeconomics, ECON 411-3 Macroeconomics, ECON 480-1 Econometrics, ECON 480-2 Econometrics and ECON 480-3 Econometrics with a Grade Point Average of 3.0 and achieve an "MA Pass" on the written qualifying examinations are eligible to receive the MA degree.

Students in Other PhD Programs

The following requirements apply to students who are enrolled in other doctoral programs and to Economics and Financial Economics doctoral students not completing the first-year sequences.

Total Units Required: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 411-1</td>
<td>Macroeconomics</td>
</tr>
<tr>
<td>ECON 480-1</td>
<td>Econometrics</td>
</tr>
</tbody>
</table>

Economic History or Development

One of those listed below

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 315-0</td>
<td>Topics in Economic History</td>
</tr>
<tr>
<td>ECON 323-1</td>
<td>Economic History of the United States Before 1865</td>
</tr>
<tr>
<td>ECON 323-2</td>
<td>Economic History of the United States 1865 to Present</td>
</tr>
<tr>
<td>ECON 324-0</td>
<td>Western Economic History</td>
</tr>
<tr>
<td>ECON 325-0</td>
<td>Economic Growth &amp; Development</td>
</tr>
<tr>
<td>ECON 326-0</td>
<td>The Economics of Developing Countries</td>
</tr>
<tr>
<td>ECON 327-0</td>
<td>Economic Development in Africa</td>
</tr>
<tr>
<td>ECON 420-1</td>
<td>American Economic History</td>
</tr>
<tr>
<td>ECON 420-2</td>
<td>European Economic History</td>
</tr>
</tbody>
</table>

Electives

Economics (300- or 400-level) or approved related courses

Other MA Degree Requirements
- **Examinations:** final oral examination
- **Research/Projects:** none specified
- **Master’s Thesis:** none specified
- **Other:** paper in one course carrying graduate credit

Students in the BA/MA in Economics Program

The following requirements are in addition to the requirements to obtain a BA in Economics (https://catalogs.northwestern.edu/undergraduate/arts-sciences/economics/economics-major). Students must have completed ECON 381-1 Econometrics and ECON 381-2 Econometrics as part of their BA degree.

Total Units Required: 9 including ECON 401

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 401</td>
<td>Mathematical Methods of Economic Theory (not for credit course)</td>
</tr>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 411-1</td>
<td>Macroeconomics</td>
</tr>
</tbody>
</table>
Economics PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-2</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-3</td>
<td>Microeconomics</td>
</tr>
</tbody>
</table>

ECON 411-1  Macroeconomics
ECON 411-2  Macroeconomics
ECON 411-3  Macroeconomics
ECON 480-1  Econometrics
ECON 480-2  Econometrics
ECON 480-3  Econometrics

Nine Approved Field Courses

1 must include:
• At least one course in Economic History (ECON 420-1 American Economic History (or) ECON 420-2 European Economic History), and
• Three field sequences of at least two-quarters each. A field sequence consists of two or three quarter-length courses as determined by the department.

Electrical Engineering

https://mccormick.northwestern.edu/electrical-computer/

Degree Types: MS, PhD

The Electrical Engineering (EE) (https://www.mccormick.northwestern.edu/electrical-computer/graduate) division in the Department of Electrical and Computer Engineering (https://mccormick.northwestern.edu/electrical-computer) offers programs leading to the MS and PhD degrees in EE. Areas of study include Solid-State & Photonics (design, analysis, and proof-of-concept development of solid-state and photonic devices and systems) and Signals & Systems (communication networks, signal processing, and control). When applying to the PhD or MS program (https://www.mccormick.northwestern.edu/electrical-computer/graduate), students should specify EE as the division which will represent their major field of study.

EE faculty also participate in other graduate programs on campus. For details and contact information, see the respective web sites for each program:

• Master of Science in Information Technology (https://www.mccormick.northwestern.edu/information-technology)
• Master of Science in Robotics (https://www.mccormick.northwestern.edu/robotics)

Degrees Offered

• Electrical Engineering MS (p. 59)
• Electrical Engineering PhD (p. 60)
Electrical Engineering MS
Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Common Requirements

Three plans are available, as shown below. For all three plans, the following are required:

- A total of 12 units.
- All courses must be at the 300-level or higher
  - However, ELEC_ENG 302-0 Probabilistic Systems is not considered a graduate-level course and cannot be counted.
- At least 9 courses from Electrical Engineering, Computer Engineering, or Computer Science. Any courses taken outside ECE or CS must be approved by the student’s advisor.
- At least 6 courses from the Core Electrical Engineering list below.
- At least 3 courses at the 400-level (ELEC_ENG 590-0 Research does not count at a 400-level course).
- The only P/N course acceptable for the master’s degree program is ELEC_ENG 590-0 Research.
- Additional requirements are listed in the ECE graduate study manual.

Plan 1: Thesis

Additional requirements:

- Up to three credits may be ELEC_ENG 590-0 Research.
- A written thesis is required, in a format specified by the thesis committee.

Plan 2: Project

Additional requirements:

- Up to two credits may be ELEC_ENG 590-0 Research.
- A project report is required, in a format specified by the project committee.

Plan 3: Course-only

Additional requirements:

- ELEC_ENG 590-0 Research may not be included in the 12 required units.

Core Electrical Engineering Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEC_ENG 307-0</td>
<td>Communications Systems</td>
</tr>
<tr>
<td>ELEC_ENG 308-0</td>
<td>Advanced Electromagnetics and Photonics</td>
</tr>
<tr>
<td>ELEC_ENG 326-0</td>
<td>Electronic System Design I</td>
</tr>
<tr>
<td>ELEC_ENG 327-0</td>
<td>Electronic System Design II: Project</td>
</tr>
<tr>
<td>ELEC_ENG 332-0</td>
<td>Introduction to Computer Vision</td>
</tr>
<tr>
<td>ELEC_ENG 333-0</td>
<td>Introduction to Communication Networks</td>
</tr>
<tr>
<td>ELEC_ENG 353-0</td>
<td>Digital Microelectronics</td>
</tr>
<tr>
<td>ELEC_ENG 359-0</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>ELEC_ENG 360-0</td>
<td>Introduction to Feedback Systems</td>
</tr>
<tr>
<td>ELEC_ENG 363-0</td>
<td>Digital Filtering</td>
</tr>
<tr>
<td>ELEC_ENG 374-0</td>
<td>Introduction to Digital Control</td>
</tr>
<tr>
<td>ELEC_ENG 375-0</td>
<td>Machine Learning: Foundations, Applications, and Algorithms</td>
</tr>
<tr>
<td>ELEC_ENG 378-0</td>
<td>Digital Communications</td>
</tr>
<tr>
<td>ELEC_ENG 379-0</td>
<td>Lasers and Coherent Optics</td>
</tr>
<tr>
<td>ELEC_ENG 380-0</td>
<td>Wireless Communications</td>
</tr>
<tr>
<td>ELEC_ENG 381-0</td>
<td>Electronic Properties of Materials</td>
</tr>
<tr>
<td>ELEC_ENG 382-0</td>
<td>Photonic Information Processing</td>
</tr>
<tr>
<td>ELEC_ENG 383-0</td>
<td>Fiber-Optic Communications</td>
</tr>
<tr>
<td>ELEC_ENG 384-0</td>
<td>Solid State Electronic Devices</td>
</tr>
<tr>
<td>ELEC_ENG 385-0</td>
<td>Optoelectronics</td>
</tr>
<tr>
<td>ELEC_ENG 386-0</td>
<td>Computational Electromagnetics and Photonics</td>
</tr>
<tr>
<td>ELEC_ENG 388-0</td>
<td>Nanotechnology</td>
</tr>
<tr>
<td>ELEC_ENG 389-0</td>
<td>Superconductivity and Its Applications</td>
</tr>
<tr>
<td>ELEC_ENG 390-0</td>
<td>Introduction to Robotics</td>
</tr>
<tr>
<td>ELEC_ENG 395-0</td>
<td>Special Topics in Electrical Engineering</td>
</tr>
<tr>
<td>ELEC_ENG 398-0</td>
<td>Electrical Engineering Design</td>
</tr>
<tr>
<td>ELEC_ENG 401-0</td>
<td>Fundamentals of Electronic Devices</td>
</tr>
<tr>
<td>ELEC_ENG 402-0</td>
<td>Advanced Electronic Devices</td>
</tr>
<tr>
<td>ELEC_ENG 403-0</td>
<td>Quantum Semiconductors</td>
</tr>
<tr>
<td>ELEC_ENG 404-0</td>
<td>Quantum Electronics</td>
</tr>
<tr>
<td>ELEC_ENG 405-0</td>
<td>Advanced Photonics</td>
</tr>
<tr>
<td>ELEC_ENG 406-0</td>
<td>Nonlinear Optics</td>
</tr>
<tr>
<td>ELEC_ENG 407-0</td>
<td>Quantum Optics</td>
</tr>
<tr>
<td>ELEC_ENG 408-1</td>
<td>Classical Electrodynamics</td>
</tr>
<tr>
<td>ELEC_ENG 408-2</td>
<td>Computational Electrodynamics</td>
</tr>
<tr>
<td>ELEC_ENG 409-0</td>
<td>Semiconductor Lasers</td>
</tr>
<tr>
<td>ELEC_ENG 410-0</td>
<td>System Theory</td>
</tr>
<tr>
<td>ELEC_ENG 411-0</td>
<td>Fundamentals and Applications of Special Relativity</td>
</tr>
<tr>
<td>ELEC_ENG 414-0</td>
<td>Advanced Topics in Quantum Electronics</td>
</tr>
<tr>
<td>ELEC_ENG 418-0</td>
<td>Advanced Digital Signal Processing</td>
</tr>
<tr>
<td>ELEC_ENG 420-0</td>
<td>Digital Image Processing</td>
</tr>
<tr>
<td>ELEC_ENG 421-0</td>
<td>Multimedia Signal Processing</td>
</tr>
<tr>
<td>ELEC_ENG 422-0</td>
<td>Random Processes in Communications and Control 1</td>
</tr>
<tr>
<td>ELEC_ENG 423-0</td>
<td>Random Processes in Communications and Control 2</td>
</tr>
<tr>
<td>ELEC_ENG 424-0</td>
<td>Distributed Optimization</td>
</tr>
<tr>
<td>ELEC_ENG 425-0</td>
<td>Introduction to Nanoscale Lasers, Quantum Noise, Photons, and Measurement</td>
</tr>
<tr>
<td>ELEC_ENG 426-0</td>
<td>Signal Detection and Estimation</td>
</tr>
<tr>
<td>ELEC_ENG 427-0</td>
<td>Optical Communications</td>
</tr>
<tr>
<td>ELEC_ENG 428-0</td>
<td>Information Theory</td>
</tr>
<tr>
<td>ELEC_ENG 429-0</td>
<td>Selected Topics in Quantum Information Science and Technology</td>
</tr>
<tr>
<td>ELEC_ENG 432-0</td>
<td>Advanced Computer Vision</td>
</tr>
<tr>
<td>ELEC_ENG 433-0</td>
<td>Statistical Pattern Recognition</td>
</tr>
<tr>
<td>ELEC_ENG 435-0</td>
<td>Deep Learning: FAA</td>
</tr>
<tr>
<td>ELEC_ENG 454-0</td>
<td>Advanced Communication Networks</td>
</tr>
<tr>
<td>ELEC_ENG 463-0</td>
<td>Adaptive Filters</td>
</tr>
<tr>
<td>ELEC_ENG 475-0</td>
<td>Machine Learning: Foundations, Applications, and Algorithms</td>
</tr>
<tr>
<td>ELEC_ENG 478-0</td>
<td>Advanced Digital Communications</td>
</tr>
<tr>
<td>ELEC_ENG 495-0</td>
<td>Special Topics in Electrical Engineering</td>
</tr>
<tr>
<td>ELEC_ENG 510</td>
<td>Seminar</td>
</tr>
</tbody>
</table>

*Core EE* courses from Computer Engineering:

| COMP_ENG 303-0 | Advanced Digital Design                      |
| COMP_ENG 391-0 | CMOS VLSI Circuit Design                     |
Electrical Engineering PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

The PhD program in Electrical Engineering is divided into two Programs of Study:

- Solid-State & Photonics
- Signals & Systems

There are requirements common to both Programs as well as additional requirements specific to each Program.

Common Requirements

Course Requirements

- EE requires a minimum of 15 graded courses that count for graduate (TGS) credit, not including ELEC_ENG 590-0. The cumulative grade point average over these graded courses must be a B (3.0 GPA) or higher. Courses that provide zero units of credit do not count toward these 15 units.
- At least 6 of these 15 units must be 400- or 500-level courses.
- At most 2 of these 15 units can be ELEC_ENG 499-0. This course is reserved for projects that are not directly related to the research required for the PhD thesis or for readings in specific subjects for which the ECE Department has no regular courses. ELEC_ENG 499-0 is not intended to replace or augment the required units of ELEC_ENG 590-0.
- All PhD students are required to complete the zero-credit Responsible Conduct for Research Training (GEN_ENG 519-0) during their first year.
- A student’s adviser may require more than the minimum number of courses. In such cases, the number of required ELEC_ENG 590-0 units will be reduced accordingly.

Other PhD Requirements

- Teaching Requirement
- Qualifying Examination
- Prospectus
- Dissertation
- Final Exam (dissertation defense)

Additional requirements and processes are detailed in the Electrical Engineering Graduate Study Guide.

Solid-State & Photonics

Course Requirements

Total Units Required: 15

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEC_ENG 382-0</td>
<td>Photonic Information Processing</td>
</tr>
<tr>
<td>ELEC_ENG 383-0</td>
<td>Fiber-Optic Communications</td>
</tr>
<tr>
<td>ELEC_ENG 388-0</td>
<td>Nanotechnology</td>
</tr>
<tr>
<td>ELEC_ENG 401-0</td>
<td>Fundamentals of Electronic Devices</td>
</tr>
<tr>
<td>ELEC_ENG 402-0</td>
<td>Advanced Electronic Devices</td>
</tr>
<tr>
<td>ELEC_ENG 403-0</td>
<td>Quantum Semiconductors</td>
</tr>
<tr>
<td>ELEC_ENG 404-0</td>
<td>Quantum Electronics</td>
</tr>
</tbody>
</table>

Each student must take 5 of the following courses:

- ELEC_ENG 333-0 Introduction to Communication Networks
- ELEC_ENG 381-0 Electronic Properties of Materials
- ELEC_ENG 384-0 Solid State Electronic Devices
- ELEC_ENG 385-0 Optoelectronics
- ELEC_ENG 386-0 Computational Electromagnetics and Photonics
- ELEC_ENG 389-0 Superconductivity and Its Applications
- ELEC_ENG 407-0 Quantum Optics
- ELEC_ENG 408-2 Computational Electrodynamics
- ELEC_ENG 409-0 Semiconductor Lasers
- ELEC_ENG 422-0 Random Processes in Communications and Control 1
- ELEC_ENG 423-0 Random Processes in Communications and Control 2
- ELEC_ENG 424-0 Distributed Optimization
- ELEC_ENG 425-0 Introduction to Nanoscale Lasers, Quantum Noise, Photons, and Measurement
- ELEC_ENG 427-0 Optical Communications
- ELEC_ENG 428-0 Information Theory
- ELEC_ENG 429-0 Selected Topics in Quantum Information Science and Technology
- ELEC_ENG 454-0 Advanced Communication Networks
- ES_APPM 411-1 Differential Equations of Mathematical Physics

Signals & Systems

Course Requirements

Total Units Required: 15

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEC_ENG 405-0</td>
<td>Advanced Photonics</td>
</tr>
<tr>
<td>ELEC_ENG 406-0</td>
<td>Nonlinear Optics</td>
</tr>
<tr>
<td>ELEC_ENG 408-1</td>
<td>Classical Electrodynamics</td>
</tr>
</tbody>
</table>

Electives must be approved by the student’s adviser, and may include the following courses:

- ELEC_ENG 333-0 Introduction to Communication Networks
- ELEC_ENG 381-0 Electronic Properties of Materials
- ELEC_ENG 384-0 Solid State Electronic Devices
- ELEC_ENG 385-0 Optoelectronics
- ELEC_ENG 386-0 Computational Electromagnetics and Photonics
- ELEC_ENG 389-0 Superconductivity and Its Applications
- ELEC_ENG 407-0 Quantum Optics
- ELEC_ENG 408-2 Computational Electrodynamics
- ELEC_ENG 409-0 Semiconductor Lasers
- ELEC_ENG 422-0 Random Processes in Communications and Control 1
- ELEC_ENG 423-0 Random Processes in Communications and Control 2
- ELEC_ENG 424-0 Distributed Optimization
- ELEC_ENG 425-0 Introduction to Nanoscale Lasers, Quantum Noise, Photons, and Measurement
- ELEC_ENG 427-0 Optical Communications
- ELEC_ENG 428-0 Information Theory
- ELEC_ENG 429-0 Selected Topics in Quantum Information Science and Technology
- ELEC_ENG 454-0 Advanced Communication Networks
- ES_APPM 411-1 Differential Equations of Mathematical Physics

ELEC_ENG 332-0 Introduction to Computer Vision
ELEC_ENG 333-0 Introduction to Communication Networks
ELEC_ENG 360-0 Introduction to Feedback Systems
ELEC_ENG 378-0 Digital Communications
ELEC_ENG 420-0 Digital Image Processing
BMD_ENG 402-0 Advanced Systems Physiology
ELEC_ENG 395-0 Special Topics in Electrical Engineering (Cardiovascular Instrumentation)
ELEC_ENG 495-0 Special Topics in Electrical Engineering (Cardiovascular Instrumentation)

Area-specific courses in Signals & Systems

Electives must be approved by the student’s adviser, and may include the following courses:

- ELEC_ENG 363-0 Digital Filtering
- ELEC_ENG 374-0 Introduction to Digital Control
- ELEC_ENG 380-0 Wireless Communications
- ELEC_ENG 418-0 Advanced Digital Signal Processing
- ELEC_ENG 421-0 Multimedia Signal Processing
Engineering Design and Innovation

https://design.northwestern.edu/engineering-design-innovation/

Degree Types: MS

The Master of Science in Engineering Design and Innovation (https://design.northwestern.edu/engineering-design-innovation) (EDI) at the Segal Design Institute is intended for recent engineering graduates seeking to lead the design of future products, services, and technologies.

Our students learn how to attack design problems with a human-centered approach to solve the needs of real people. Methods include user observation, visualization, rapid prototyping, and iteration.

EDI attracts engineers who like to create new things, are comfortable with complex problems, and care about culture and contemporary context. The coursework focuses heavily on hands-on, team-based projects. Graduates of EDI are prepared to collaborate on, and lead, development teams to create innovative and effective products and services.

Applicants should have a bachelor’s degree in engineering or a related discipline, or adequate demonstration of strong analytic skills.

Degrees Offered
- Engineering Design and Innovation MS (p. 61)

Engineering Design and Innovation MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Total Units Required: 16

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSGN 401-1</td>
<td>Human-Centered Design Studio 1</td>
</tr>
<tr>
<td>DSGN 401-2</td>
<td>Human-Centered Design Studio 2</td>
</tr>
<tr>
<td>DSGN 401-3</td>
<td>Human-Centered Design Studio 3</td>
</tr>
<tr>
<td>DSGN 410-0</td>
<td>Design Research</td>
</tr>
<tr>
<td>DSGN 420-0</td>
<td>Design Communication &amp; Methods</td>
</tr>
<tr>
<td>DSGN 450-0</td>
<td>Differentiation by Design</td>
</tr>
<tr>
<td>DSGN 455-0</td>
<td>Design Strategy</td>
</tr>
<tr>
<td>DSGN 499-0</td>
<td>Independent Research Project (taken for 1 unit in spring and 2 units in fall)</td>
</tr>
</tbody>
</table>

Electives
- Breadth electives (6 units)

Engineering Sciences and Applied Mathematics

https://www.mccormick.northwestern.edu/applied-math/

Degree Types: PhD, MS

The programs in Engineering Science and Applied Mathematics (https://www.mccormick.northwestern.edu/applied-math/graduate) educate students in mathematical methods and their application to various scientific and engineering fields.

Our program emphasizes techniques associated with asymptotic analysis, bifurcation theory, dynamical systems, numerical analysis, ordinary and partial differential equations, singular perturbations, stability theory, and stochastic processes. These techniques are employed to address problems arising in science and engineering including fluid mechanics, microbiology, neurobiology, ecology, geophysics, materials, diffusion processes, fiber optics, interfacial phenomena, pattern formation, solid mechanics, solidification theory, wave phenomena, and social sciences.

Students are given broad-based training encompassing mathematical methods and fields of science or engineering where significant applications of mathematics are made.

Degrees Offered
- Engineering Sciences and Applied Mathematics MS (p. 61)
- Engineering Sciences and Applied Mathematics PhD (p. 62)

Engineering Sciences and Applied Mathematics MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Total Units Required: 12

(An overall grade average of B or better is required for the courses listed below.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES_APPM 411-1</td>
<td>Differential Equations of Mathematical Physics or ES_APPM 311-1 Methods of Applied Mathematics</td>
</tr>
<tr>
<td>ES_APPM 411-2</td>
<td>Differential Equations of Mathematical Physics or ES_APPM 311-2 Methods of Applied Mathematics</td>
</tr>
<tr>
<td>ES_APPM 420-1</td>
<td>Asymptotic and Perturbation Methods in Applied Mathematics</td>
</tr>
<tr>
<td>ES_APPM 446-1</td>
<td>Numerical Solution of Partial Differential Equations</td>
</tr>
<tr>
<td>ES_APPM 448-0</td>
<td>Numerical Methods for Random Processes</td>
</tr>
<tr>
<td>ES_APPM 444-0</td>
<td>High Performance Scientific Computing</td>
</tr>
</tbody>
</table>
or ES_APPM 445-0  
Iterative Methods for Elliptic Equations

Mathematical Modeling Electives (approved; 3 units)
Mathematical Content Electives (approved; 3 units)

Other MS Degree Requirements

- **Mathematical Content Electives Theme**: Courses selected to complete the Mathematical Content Electives must be mathematics courses related by a defined theme chosen by the student.
- **Mathematical Modeling Electives Theme**: Courses selected to complete the Mathematical Modeling Electives must be application areas that use mathematical methods and be related by a defined theme chosen by the student.
- **Master's Thesis (optional)**: Up to two units of the Mathematical Modeling Electives Theme may be replaced with ES_APPM 590 for work culminating in a Master's thesis consisting of original research and approved by a thesis committee.

### Engineering Sciences and Applied Mathematics PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

#### PhD

**Total Units Required: 18**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES_APPM 411-1</td>
<td>Differential Equations of Mathematical Physics</td>
</tr>
<tr>
<td>ES_APPM 411-2</td>
<td>Differential Equations of Mathematical Physics</td>
</tr>
<tr>
<td>ES_APPM 411-3</td>
<td>Differential Equations of Mathematical Physics</td>
</tr>
<tr>
<td>ES_APPM 412-0</td>
<td>Methods of Nonlinear Analysis</td>
</tr>
<tr>
<td>ES_APPM 420-1</td>
<td>Asymptotic and Perturbation Methods in Applied Mathematics</td>
</tr>
<tr>
<td>ES_APPM 420-2</td>
<td>Asymptotic and Perturbation Methods in Applied Mathematics</td>
</tr>
<tr>
<td>ES_APPM 421-1</td>
<td>Models in Applied Mathematics</td>
</tr>
<tr>
<td>ES_APPM 445-0</td>
<td>Iterative Methods for Elliptic Equations</td>
</tr>
<tr>
<td>ES_APPM 446-1</td>
<td>Numerical Solution of Partial Differential Equations</td>
</tr>
<tr>
<td>ES_APPM 448-0</td>
<td>Numerical Methods for Random Processes</td>
</tr>
<tr>
<td>ES_APPM 444-0</td>
<td>High Performance Scientific Computing</td>
</tr>
<tr>
<td>GEN_ENG 519-0</td>
<td>Responsible Conduct for Research Training</td>
</tr>
</tbody>
</table>

Mathematical Modeling Electives (approved; 2 units)

Mathematical Content Electives (approved; 3 units)

#### Other PhD Degree Requirements

- **Examinations**: written preliminary examinations in differential equations, advanced calculus, complex variables and linear algebra; oral qualifying examination for admission to candidacy
- **English Language Proficiency**: meet The Graduate School’s spoken English proficiency requirement (https://www.tgs.northwestern.edu/funding/assistantships/graduate-and-teaching.html) to be a teaching assistant (p. 22)
- **PhD Dissertation**: original research, defended before student's doctoral committee
- **Final Evaluations**: oral presentation and faculty evaluation when all other requirements complete

### English

#### Degree Types: PhD, MA, MFA/MA dual degree

The Graduate Program in the Department of English (https://www.english.northwestern.edu/graduate) offers advanced study and research in literary history, criticism, and theory, with excellent opportunities for interdepartmental and interdisciplinary study. Courses within the department cover major genres, periods, authors, and a broad range of methodological and theoretical approaches.

The graduate curriculum is enhanced by frequent lectures and workshops with Northwestern faculty and visiting scholars from around the world. Student-organized colloquia, conferences, reading groups, and dissertation groups provide opportunities for students to present their research to an audience of peers.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Cluster Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program, please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).

#### Degrees Offered

- Creative Writing and English MFA/MA (p. 53)
- English MA (p. 62)
- English PhD (p. 63)

### English MA

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

#### Master's

**Total Units Required: 9**

Nine courses, at least five of which must be at the graduate level (400 or 500-level).

- Up to four courses can be from the list of approved upper-level undergraduate courses (300-level).
- Up to three courses may be taken in related departments.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGLISH 499-0</td>
<td>Independent Study</td>
</tr>
</tbody>
</table>

#### Other MA Degree Requirements

- Approved 400-level courses (minimum 3 units)
- Approved 500-level courses (minimum 6 units)
- Approved 600-level courses (minimum 1 unit)
- Approved 700-level courses (minimum 1 unit)
- Approved 800-level courses (minimum 1 unit)
- Approved 900-level courses (minimum 1 unit)

The nine courses above are subject to the following additional restrictions:

- Three seminars in related departments; can be at the 400-level or, with approval, the 500-level
- Two 400-level courses focusing on pre-1800 literature
- Two 400-level courses focusing on post-1800 literature

1 must be at the 400-level, ENGLISH 499-0 Independent Study is not an option
The Finance doctoral program trains students to apply empirical methods and theoretical tools to advance our understanding of how financial markets and institutions work, and how they may contribute to economic development.

The program aims to produce scholars who develop rigorous and creative research in finance and economics. Students are exposed to a variety of research methods in their coursework, and interact closely with faculty as they develop their own research projects. A distinctive characteristic of our program is its close ties with the Department of Economics, which are fostered by joint seminars, mutual advising of students, and frequent collaboration on research projects. The academic interests of the finance faculty also span a very broad range of topics in finance, from the role of culture and trust in financial markets to the identification of jump risk premiums. The breadth of knowledge and interests of our faculty create an environment that encourages students to conduct advanced research in novel aspects of the field.

Degrees Offered

- Finance PhD (p. 63)

Finance PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 27

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGLISH 410-0</td>
<td>Introduction to Graduate Study</td>
</tr>
<tr>
<td>Four 400-level English Department courses focusing on pre-1800 literature</td>
<td>¹</td>
</tr>
<tr>
<td>Four 400-level English Department courses focusing on post-1800 literature</td>
<td>¹</td>
</tr>
<tr>
<td>Eighteen Electives</td>
<td>²</td>
</tr>
</tbody>
</table>

¹ must be at the 400-level, ENGLISH 499-0 Independent Study is not an option
² including ENGLISH 490-0 Independent Reading, ENGLISH 499-0 Independent Study, and ENGLISH 570-0 Seminar in Teaching Composition

Other PhD Degree Requirements

- Examinations: first-year review; for admission to candidacy, language examination to demonstrate competence in a language other than English, two-part qualifying examination in area of specialization, and submission of approved dissertation prospectus by end of third year
- PhD Dissertation: must be completed within nine years after original matriculation, though faster completion strongly urged
- Final Evaluations: defense of dissertation
- Other: instructional duties as designated by department

Please note: changes to English PhD degree requirements are pending review and approval in fall 2019.

Finance

https://www.kellogg.northwestern.edu/faculty/academics/finance.aspx

Degree Types: PhD

The Finance doctoral program provides students with rigorous training in finance, economics, mathematics and statistics. These tools, plus opportunities for supervised independent research, enable students to make their own contributions to the understanding of financial markets and institutions that lead to productive research careers.

The Finance doctoral program trains students to apply empirical methods and theoretical tools to advance our understanding of how financial markets and institutions work, and how they may contribute to economic development.

Northwestern University
The study of finance aligns with numerous areas within economics: macroeconomics, public finance, econometrics, economic development and economic history. This is why a broad training in economics is essential for those who wish to do innovative work that straddles both finance and economics. Some examples include the financing and investment decisions of firms, households, and governments; the interplay between asset prices, capital markets and the macro-economy; and the role and limitations of financial institutions in facilitating access to credit.

Students will complete the existing first-year Economics program that provides a rigorous foundation in macroeconomics, microeconomics and econometrics. Students will then take courses in theoretical and empirical finance, as well as additional fields in economics such as economic theory, economic history, macroeconomics, industrial organization and regulation, labor economics, economic development, econometrics, international economics, and public finance. Students are trained in the most advanced techniques of theoretical and empirical research in order to make significant contributions to financial theory and practice.

Independent thesis research will be supervised by faculty drawn from both the Economics and Finance Departments.

Weekly workshop series in both departments provide a forum for faculty, students, and distinguished economists from around the world to meet and present their research.

**Degrees Offered**

- Financial Economics PhD (p. 64)

**Financial Economics PhD**

**Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Total Units Required: 18**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-2</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-3</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 411-1</td>
<td>Macroeconomics</td>
</tr>
<tr>
<td>ECON 411-2</td>
<td>Macroeconomics</td>
</tr>
<tr>
<td>ECON 411-3</td>
<td>Macroeconomics</td>
</tr>
<tr>
<td>ECON 480-1</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 480-2</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 480-3</td>
<td>Econometrics</td>
</tr>
</tbody>
</table>

**Field Sequences**

Nine Approved Field Courses that must include:

- At least two courses in Asset Pricing
  - FINC 585-1 Asset Pricing I
  - FINC 585-2 Asset Pricing II
  - FINC 585-3 Asset Pricing III

- At least two courses in Corporate Finance
  - FINC 586-1 Corporate Finance I
  - FINC 586-2 Corporate Finance II
  - FINC 586-3 Corporate Finance III

Two approved Economics field sequences of at least two quarters each

- At least one course in Economic History
  - ECON 420-1 American Economic History
  or ECON 420-2 European Economic History
Other PhD Degree Requirements

- Examinations: preliminary examinations in economic theory (microeconomics, macroeconomics, and econometrics); oral examination for approval of dissertation prospectus
- Finance Comprehensive Exam: Students must pass a Finance Competence Requirement. This can be done by achieving a 3.6 GPA across the six finance doctoral courses (FINC 585-1 Asset Pricing I, FINC 585-2 Asset Pricing II, FINC 585-3 Asset Pricing III and FINC 586-1 Corporate Finance I, FINC 586-2 Corporate Finance II, FINC 586-3 Corporate Finance III), or by passing a comprehensive Finance exam. The Exam takes place at the beginning of the summer quarter of the second year, typically in June.
- Research/Projects: two research papers presented in the student seminar (ECON 501-0 Graduate Student Seminar) or equivalent
- PhD Dissertation: original, independent research
- Final Evaluations: oral dissertation defense
- Supervised Teaching Experience

French and Francophone Studies

https://www.frenchanditalian.northwestern.edu/graduate/

Degree Types: PhD

The PhD Program in French and Francophone Studies (https://www.frenchanditalian.northwestern.edu/graduate) focuses on literary and cultural production from the Francophone world. The program is distinguished by a deep exploration of the continued impact French literature and culture has on modern literary theory, philosophy, and critical thought.

The research and teaching of our faculty exhibits particular strength in the areas of twentieth-century literature and contemporary theory, film and visual culture across periods, Francophone studies, seventeenth- and eighteenth-century studies, and gender studies.

The program is strongly committed to interdisciplinary study and allows students to tailor courses to extend beyond traditional boundaries. Students benefit from a wide array of resources - including Northwestern Library's outstanding Africana collection (https://www.library.northwestern.edu/libraries-collections/herskovits-library) - and from close interaction with experts in related fields of gender studies, film, art history, philosophy, and comparative literature.

Degrees Offered

- French and Francophone Studies PhD (p. 65)

French and Francophone Studies PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Minimum eighteen credits for candidacy (including FRENCH 493-0 Topics in Literary Theory (the Program's introductory theory course) with different content.

Total Units Required (by end of Year 3): 24

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Year</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fall</strong></td>
<td>Nine courses in French and Francophone Studies and other departments, as follows:</td>
</tr>
<tr>
<td></td>
<td>2 French and Francophone courses, 1 elective</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
</tr>
<tr>
<td></td>
<td>2 French and Francophone courses, 1 elective</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
</tr>
<tr>
<td></td>
<td>2 French and Francophone courses, 1 elective</td>
</tr>
<tr>
<td></td>
<td>Total Units (Year 1): 9</td>
</tr>
<tr>
<td><strong>Second Year</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fall</strong></td>
<td>Six courses in French and Francophone Studies or other departments; must take 4 seminars offered by the department not in the theory sequence.</td>
</tr>
<tr>
<td></td>
<td>FRENCH 498-0 Independent Reading (teaching assignment)</td>
</tr>
<tr>
<td></td>
<td>Total Units (Year 2): 9</td>
</tr>
<tr>
<td><strong>Third Year</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fall</strong></td>
<td>Fall Quarter: 2 courses in French and Francophone Studies or other departments</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
</tr>
<tr>
<td></td>
<td>FRENCH 596-0 PhD Thesis Tutorial</td>
</tr>
<tr>
<td></td>
<td>FRENCH 498-0 Independent Reading (teaching assignment)</td>
</tr>
<tr>
<td></td>
<td>Total Units (Year 3): 6</td>
</tr>
</tbody>
</table>

Other PhD Degree Requirements

- Examinations: For admission to candidacy, written examinations conducted in three phases:
  
a. A theory exam, based on a critical theory reading list, conducted prior to the beginning of fall classes in the student's second year;
  
b. A literature exam based on a list of works of French and Francophone literature and film;
  
c. A third-year qualifying/prospectus exam, focusing on methodological issues and a corpus of primary texts related to the student's prospective dissertation project, conducted in the winter of the third year.

There are three possible outcomes of the qualifying/prospectus exam. If the student does not pass the exam on the first try, he or she will be given the opportunity, during the following quarter, to rewrite the section(s) of the exam that were deemed unsatisfactory. If, however, on the second attempt the results are still unsatisfactory, the student will not pass and may be granted a terminal master's degree at the discretion of the faculty.

- First- and Second-Year Review: These reviews are conducted at the end of the spring quarter of the first and second year. The student's performance is assessed based on a dossier including the student's self-evaluation, evaluations by instructors, and a seminar paper submitted by the student.
- PhD Dissertation: Original and significant contribution to French and Francophone studies; may be written in English or French.
- Oral Defense: Defense of the dissertation before dissertation committee. The student may decide to opt for a public defense.
• Other: Teaching assignments or graduate assistantships starting in year two.

Master's
The department does not admit students for the MA degree, but will award the MA to a PhD candidate if deemed in the student's best interest. At least two years of graduate courses, plus any supplementary courses and/or examinations recommended by faculty, are required.

**Genetic Counseling**
https://www.cgm.northwestern.edu/education/graduate-genetic-medicine/index.html

Degree Types: MS
The Graduate Program in Genetic Counseling (https://www.cgm.northwestern.edu/education/graduate-genetic-medicine) is a six-quarter (18-month) program leading to a master's in Genetic Counseling and accredited by the Accreditation Council for Genetic Counseling (ACGC). The curriculum is designed to emphasize the scientific and medical aspects of the profession, along with the counseling and psychosocial aspects. Students have extensive course work their first year and also begin their clinical rotations during the winter quarter. Early clinical placements allow the students to quickly apply and reinforce the concepts they learn in the classroom. In addition, Northwestern has a strong research component, requiring a written thesis and oral defense (https://www.cgm.northwestern.edu/education/graduate-genetic-medicine/program-description/thesis-project.html). Graduates are prepared for employment as genetic counselors in multiple settings including:

• Multidisciplinary medical settings including pediatrics, prenatal, adult, cancer and other subspecialties.
• Laboratories, government agencies, research, public health and industry.

Students are prepared for the ABGC certification examination through coursework, thesis and clinical experiences supervised by certified genetic counselors and clinical geneticists.

**Degrees Offered**
• Genetic Counseling MS (p. 66)

**Genetic Counseling MS**

**Degree Requirements**
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master's**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENET_CN 401-0</td>
<td>Introduction to Genetic Counseling</td>
</tr>
<tr>
<td>GENET_CN 420-0</td>
<td>Principles of Medical Genetics I</td>
</tr>
<tr>
<td>GENET_CN 421-0</td>
<td>Research Methods</td>
</tr>
<tr>
<td>GENET_CN 422-0</td>
<td>Genetics Journal Club</td>
</tr>
<tr>
<td>GENET_CN 411-0</td>
<td>Psychosocial Aspects of Genetic Counseling I</td>
</tr>
</tbody>
</table>

View all current course requirements by visiting the Genetic Counseling website (https://www.cgm.northwestern.edu/education/graduate-genetic-medicine/program-description/curricula.html).

**Other MS Degree Requirements**
• Research/Projects: Design and conduct original research project with genetic counseling focus, to be presented at an oral defense and a public colloquium, and submitted to the Program in the form of a publishable manuscript. We encourage all students to submit their abstracts to a professional meeting, and to publish their work in a professional journal.

**German Literature and Critical Thought**
https://www.german.northwestern.edu/

Degree Types: PhD
The Department of German (https://www.german.northwestern.edu) offers a graduate program focused on the theoretical and cultural foundations of German literature, critical thought, and media from 1750 onward.

The program consists of six required and twelve elective courses. Students are encouraged to choose electives in related disciplines such as art history, comparative literary studies, film studies, French/Italian, history, philosophy, Slavic, Spanish, African-American studies, and Jewish studies.

Students in this program are also encouraged to participate in TGS's Interdisciplinary Cluster Initiative program. For more information on how you can have a second intellectual "home" outside of your department or program, please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).
Degrees Offered

- German Literature and Critical Thought PhD (p. 67)

German Literature and Critical Thought PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERMAN 401-0</td>
<td>German Literature and Critical Thought 1750-1832</td>
</tr>
<tr>
<td>GERMAN 402-0</td>
<td>History of Literature and Critical Thought 1832-1900</td>
</tr>
<tr>
<td>GERMAN 403-0</td>
<td>German Literature, Critical Thought and New Media 1900-1945</td>
</tr>
<tr>
<td>GERMAN 404-0</td>
<td>German Literature, Critical Thought and New Media since 1945</td>
</tr>
<tr>
<td>GERMAN 405-0</td>
<td>Basic Issues in Foreign Language Teaching</td>
</tr>
<tr>
<td>GERMAN 407-0</td>
<td>Proseminar</td>
</tr>
</tbody>
</table>

Electives

- Twelve courses from those listed below and related disciplines
  - GERMAN 322-0: German Contributions to World Literature
  - GERMAN 324-0: Modern German Drama
  - GERMAN 431-0: Contemporary German Literature
  - GERMAN 441-0: Studies in Communication and Culture
  - GERMAN 490-0: Independent Reading
  - GERMAN 499-0: Independent Study
  - GERMAN 590-0: Research

Other PhD Degree Requirements

- Graduate Colloquium: Participation in seminars and workshops under this rubric during all quarters in residence
- Examinations: Comprehensive examination for admission to candidacy
- Research/Projects: Extensive research papers related to seminar topics
- Prospectus: Writing and defense of prospectus
- PhD Dissertation: Original independent research
- Final Evaluations: Oral defense of the dissertation

Health and Biomedical Informatics

https://www.preventivemedicine.northwestern.edu/divisions/health-and-biomedical-informatics/index.html

Degree Types: MS

Informatics methods are becoming standard in many areas of biological and medical research. However, much of this research and training centers around using HBMI tools to answer research questions. In contrast, HBMI training focuses on building new tools.

HBMI is frequently compared to computer science and information technology. While Informatics uses computers, it is not fundamentally about computers or technology. Rather, it is about the information. In addition, computer science focuses on generalized solutions to generalized problems. Informatics tends to focus on the specifics of target domains that make them resistant to generalized solutions. While most informatics students learn some computer programming, the computer courses are a small fraction of the total curriculum.

Students in this program are required to complete and defend a master's thesis to satisfy the requirement for graduation. An examination committee for an MS thesis consists of at least three faculty members.

This program is geared primarily toward doctorally-prepared researchers who wish to gain additional experience in HBMI. Students in this program take courses with those in our doctoral programs. Individuals interested in Health IT and Operational Informatics are encouraged to look into the MS in Health Informatics (MHI) program (https://sps.northwestern.edu/masters/health-informatics). Individuals interested in a PhD should look into the Informatics track of the HSIP or DGP program.

Degrees Offered

- Health and Biomedical Informatics MS (p. 67)

Health and Biomedical Informatics MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's Requirements

Total Units Required: 13

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td></td>
</tr>
<tr>
<td>9 courses from core competencies and selective requirements:</td>
<td></td>
</tr>
<tr>
<td>HSIP 440-0</td>
<td>Introduction to Medical Informatics</td>
</tr>
<tr>
<td>HSIP 441-0</td>
<td>Health and Biomedical Informatics Methods I</td>
</tr>
<tr>
<td>HSIP 442-0</td>
<td>Biomedical Informatics Methods II</td>
</tr>
<tr>
<td>HSIP 443-0</td>
<td>Biomedical Informatics Methods III</td>
</tr>
<tr>
<td>One course from Statistics</td>
<td></td>
</tr>
<tr>
<td>One course from Health Care and Biomedical Domain Knowledge</td>
<td></td>
</tr>
<tr>
<td>One course from Computation</td>
<td></td>
</tr>
<tr>
<td>Two selectives, electives, or research hours</td>
<td></td>
</tr>
<tr>
<td>Second Year</td>
<td></td>
</tr>
<tr>
<td>5 courses from core competencies, electives, or elective requirements:</td>
<td></td>
</tr>
<tr>
<td>2-3 courses from track requirements, electives, or electives</td>
<td></td>
</tr>
<tr>
<td>1-2 courses in thesis development/completion</td>
<td></td>
</tr>
</tbody>
</table>

Other MA Degree Requirements

- Mentor-evaluated research/thesis

Health Sciences Integrated Program

http://www.feinberg.northwestern.edu/sites/cehs/phd-program/index.html

Degree Types: PhD

The Health Sciences Integrated Program (HSIP) (http://www.feinberg.northwestern.edu/sites/cehs/phd-program) offers doctoral
student training in multiple disciplines within the health sciences. PhD students can choose to focus studies on:

- Health and Biomedical Informatics
- Health Services and Outcomes Research
- Healthcare Quality and Patient Safety
- Social Sciences and Health

The PhD program builds upon existing master’s degree programs in these fields and incorporates new areas of strength in measurement and health behavior. Doctoral students receive rigorous interdisciplinary training in the core content needed for population research in the 21st century.

Each student develops an individualized course of study that draws on the broad and deep resources found in The Graduate School and the Feinberg School of Medicine. HSIP provides a strong academic foundation for students to excel in research that addresses processes and methodologies in the clinical and population sciences.

The ultimate goal of program is to produce graduates who will be leaders in translational science with the ability to connect approaches and methods from multiple disciplines.

Degrees Offered
- Health Sciences Integrated Program PhD (p. 68)

Health Sciences Integrated Program PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

The Health Sciences Integrated Program requires:

- Coursework (see track-specific requirements below).
- Two written Qualifying Exams and an oral defense.
- Teaching experience.
- Written Dissertation Proposal and an oral defense.
- Doctoral Dissertation and an oral defense.

Health and Biomedical Informatics Track

Informatics is the study of information: how you collect it, how you organize it, and how you use it to solve problems. Health and Biomedical Informatics is informatics applied to healthcare and biomedical research. This track contains many different sub-fields that use similar techniques and tools but apply them to different problem areas.

Total Units Required: 12.5, 13, or 13.5

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSIP 400-1</td>
<td>Interdisciplinary Health Sciences Doctoral Colloquium</td>
</tr>
<tr>
<td>HSIP 401-0</td>
<td>Introduction to Health Measurement Science</td>
</tr>
<tr>
<td>HSIP 440-0</td>
<td>Introduction to Medical Informatics</td>
</tr>
<tr>
<td>HSIP 441-0</td>
<td>Health and Biomedical Informatics Methods I</td>
</tr>
<tr>
<td>HSIP 442-0</td>
<td>Health and Biomedical Informatics Methods II</td>
</tr>
<tr>
<td>HSIP 443-0</td>
<td>Health and Biomedical Informatics Methods III</td>
</tr>
<tr>
<td>EPL_BIO 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>EPL_BIO 402-0</td>
<td>Intermediate Biostatistics *</td>
</tr>
<tr>
<td>HSR 462-0</td>
<td>Topics in Health Services Research: Grant Writing (0.5 credit) **</td>
</tr>
</tbody>
</table>

Choose one Health Care and Biomedical Knowledge:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQS 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>HSR 470-0</td>
<td>Federal Policy Making and Health Care Reform</td>
</tr>
<tr>
<td>IGP 401-0</td>
<td>Biochemistry I</td>
</tr>
<tr>
<td>IGP 405-0</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>IGP 410-0</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>IGP 430-0</td>
<td>Genetics</td>
</tr>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>PUB_HLTH 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
</tbody>
</table>

Choose one Computation:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_HLTH 305-0</td>
<td>Applied Statistical Programming in SAS</td>
</tr>
</tbody>
</table>

Electives

Choose at least 3 of the following: ***

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQS 440-0</td>
<td>Fundamental Methods for Healthcare Quality and Patient Safety</td>
</tr>
<tr>
<td>HSR 425-0</td>
<td>Introduction to Quantitative Methods in Health Services &amp; Outcomes Research</td>
</tr>
<tr>
<td>HSR 433-0</td>
<td>Health Economics and Healthcare Financing</td>
</tr>
<tr>
<td>HSR 460-0</td>
<td>Ethical Issues in Health Services Research (0.5 credit)</td>
</tr>
<tr>
<td>IBIS 401-0</td>
<td>Molecular Biophysics</td>
</tr>
<tr>
<td>IBIS 403-0</td>
<td>The Human Proteome: Defining Variation and Modifications of Protein Molecules</td>
</tr>
<tr>
<td>IBIS 407-0</td>
<td>Genetics &amp; Epigenetics</td>
</tr>
<tr>
<td>IBIS 410-0</td>
<td>Quantitative Biology</td>
</tr>
<tr>
<td>IGP 422-0</td>
<td>Introduction to Translational Research</td>
</tr>
<tr>
<td>IGP 466-0</td>
<td>Structural Basis of Signal Transduction</td>
</tr>
<tr>
<td>PUB_HLTH 425-0</td>
<td>Introduction to GIS and Spatial Analysis for Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 445-0</td>
<td>Writing and Peer Reviewing for Scientific Publication</td>
</tr>
</tbody>
</table>

* If students have a background in calculus, they should take EPL_BIO 402-0 Intermediate Biostatistics to fulfill the Intermediate Biostatistics requirement. Students without prior calculus should take PUB_HLTH 421-0 Intermediate Biostatistics, CLIN_PSY 426-0 Research Methods I or other equivalent approved by the student’s adviser.

** The requirement for a grant writing course my also be fulfilled by taking DGP 496-3 in the Summer quarter for zero credit.

*** Other electives may be taken with adviser approval.

Health Services and Outcomes Research Track

This track covers a multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviors affect access to health care, the quality and cost of health care, and ultimately our health and well-being. Its research domains are individuals, families, organizations, institutions, communities, and populations.

Total Units Required: 14.5

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSIP 400-1</td>
<td>Interdisciplinary Health Sciences Doctoral Colloquium</td>
</tr>
<tr>
<td>HSIP 401-0</td>
<td>Introduction to Health Measurement Science</td>
</tr>
<tr>
<td>HSR 425-0</td>
<td>Introduction to Quantitative Methods in Health Services &amp; Outcomes Research</td>
</tr>
</tbody>
</table>
Healthcare Quality and Patient Safety Track
This track focuses on the knowledge, skills, and methods required for improving healthcare delivery systems in regard to quality and safety. The topics covered include: healthcare quality context and measurement, changing systems of care delivery, healthcare disparities, accountability and public policy, safety interventions and practices, health information technology, simulation and the sciences of teamwork, human factors, risk assessment methods, and leadership and governance.

Total Units Required: 13

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSIP 400-1</td>
<td>Interdisciplinary Health Sciences Doctoral Colloquium</td>
</tr>
<tr>
<td>HSIP 401-0</td>
<td>Introduction to Health Measurement Science</td>
</tr>
<tr>
<td>HQS 401-0</td>
<td>Introduction to Healthcare Quality</td>
</tr>
<tr>
<td>HQS 402-0</td>
<td>Introduction to Patient Safety</td>
</tr>
<tr>
<td>HQS 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>HQS 440-0</td>
<td>Fundamental Methods for Healthcare Quality and Patient Safety</td>
</tr>
<tr>
<td>HQS 501-0</td>
<td>Advanced Healthcare Quality</td>
</tr>
<tr>
<td>HQS 502-0</td>
<td>Advanced Patient Safety</td>
</tr>
<tr>
<td>HQS 510-0</td>
<td>The Business of Healthcare Quality and Safety Improvement</td>
</tr>
<tr>
<td>PUB_HLTH 323-0</td>
<td>Health Equity</td>
</tr>
</tbody>
</table>

Choose one Research Design:
- PUB_HLTH 445-0 Writing and Peer Reviewing for Scientific Publication

Recommended Electives
Choose at least 2 of the following:
- EPI_BIO 402-0 Intermediate Biostatistics
- HSR 433-0 Health Economics and Healthcare Financing
- HSR 456-0 Applied Qualitative Methods and Analysis for Health Researchers
- HSR 470-0 Federal Policy Making and Health Care Reform
- MHB 401-0 Foundations of Bioethics
- MHB 402-0 Medicine & Law
- MHB 403-0 The History of Medicine and Bioethics
- MORS 430-0 Leadership in Organizations

* Other electives may be taken with adviser approval.

* Independent study or other approved elective
** If students have a background in calculus, they should take EPI_BIO 402-0 Intermediate Biostatistics to fulfill the Intermediate Biostatistics requirement. Students without prior calculus should take either PUB_HLTH 421-0 Intermediate Biostatistics or CLIN_PSY 426-0 Research Methods I or other equivalent approved by the student’s adviser.

Social Sciences and Health Track
The educational mission of this track is to prepare its graduates for scholarly and research careers in patient centered outcomes, their mechanisms, and intervention applications via training at the scientific interface of biomedical and social sciences. Particular emphasis is placed on measurement of quality of life, behavioral and functional outcomes, applications that improve quality of life, health and health care at the individual and systems levels, as well as the developmental mechanisms that shape these outcomes across the lifespan. The overarching goal of this track is to train scientists who are experts in a particular area of patient-centered outcomes research (e.g. outcomes sciences, developmental mechanisms, behavior and health), while also developing proficiency in multiple areas of relevance to leading an innovative team.

Total Units Required: 14.5

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSIP 400-1</td>
<td>Interdisciplinary Health Sciences Doctoral Colloquium</td>
</tr>
<tr>
<td>HSIP 401-0</td>
<td>Introduction to Health Measurement Science</td>
</tr>
<tr>
<td>HSIP 430-0</td>
<td>Introduction to Social Sciences and Health</td>
</tr>
<tr>
<td>EPI_BIO 301-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>or HSR 425-0</td>
<td>Introduction to Quantitative Methods in Health Services &amp; Outcomes Research</td>
</tr>
<tr>
<td>EPI_BIO 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>or PUB_HLTH 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>EPI_BIO 402-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>or PUB_HLTH 421-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>HSR 460-0</td>
<td>Ethical Issues in Health Services Research *</td>
</tr>
<tr>
<td>HSR 462-0</td>
<td>Topics in Health Services Research: Grant Writing ((0.5 credit))</td>
</tr>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>PUB_HLTH 445-0</td>
<td>Writing and Peer Reviewing for Scientific Publication</td>
</tr>
</tbody>
</table>

Choose one of the following required courses:
- ANTHRO 306-0 Evolution of Life Histories
- PSYCH 401-2 Proseminar–Social and Personality Bases of Behavior
- STAT 348-0 Applied Multivariate Analysis

Recommended Electives
Choose four elective courses from the following:
- PUB_HLTH 302-0 Introduction to Biostatistics
- STAT 348-0 Applied Multivariate Analysis
- MORS 452-0 Leading the Strategic Change Process
- PUB_HLTH 430-0 Leading and Managing Teams
- PUB_HLTH 415-0 Disease Prevention and Health Promotion: Principles and Application
- PUB_HLTH 431-0 Basic Decision Analysis and Models of Medical Decision Making
- PUB_HLTH 438-0 Survey Design & Methodology
- PUB_HLTH 439-0 Qualitative Research Methods
- PUB_HLTH 444-0 Advanced Decision Analysis
- PUB_HLTH 449-0 Public Health Policy
The Master of Science in Health Services and Outcomes Research (https://www.feinberg.northwestern.edu/sites/cehs/our-programs/health-services-outcomes-research/index.html) (HSOR) provides training in research methods and the substantive field of health services and outcomes research. Health services and outcomes research can play a critical role in informing the healthcare policymaking process; developing clinical practice improvements; reducing healthcare disparities; and shaping the future organization and delivery of healthcare.

The Master of Science program is designed to prepare graduates for academic faculty positions or leadership positions in research organizations in the public or private sector. After completing the program, students will possess the knowledge and skills to:

- Conduct methodologically sound health services and outcomes research,
- Create new knowledge aimed at improving health services and outcomes, and
- Pursue funding opportunities to support their research.

The program’s courses follow an executive format that can accommodate the professional schedules of graduate medical trainees and medical faculty. Master’s students are admitted each Summer. Students may complete the degree in either one year of full-time study or by taking courses part-time over two years.

The program emphasizes interdisciplinary and experiential-based training and allows students to tailor assignments and class work to their professional backgrounds and research interests. The curriculum focuses on the following topics:

- Biostatistics
- Quantitative methods in health services and outcomes research
- Qualitative methods and analysis
- Writing and peer review for publication
- Ethical issues in health services research
- Health economics and healthcare financing
- Grant writing

The master’s degree program also includes a capstone course sequence in which the student develops and completes a culminating research project.

In addition to the MS degree, the Health Services and Outcomes Research (HSOR) program offers graduate certificates in HSOR Methodology (https://www.feinberg.northwestern.edu/sites/cehs/our-programs/health-services-outcomes-research/curriculum.html) and Contemporary Issues in HSOR (https://www.feinberg.northwestern.edu/sites/cehs/our-programs/health-services-outcomes-research/curriculum.html).

Degrees Offered
- Health Services and Outcomes Research MS (p. 70)

Health Services and Outcomes Research MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s Requirements

Total Units Required: 10.5

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSR 425-0</td>
<td>Introduction to Quantitative Methods in Health Services &amp; Outcomes Research</td>
</tr>
<tr>
<td>HSR 465-0</td>
<td>Intermediate Quantitative Methods in Health Services &amp; Outcomes Research</td>
</tr>
<tr>
<td>PUB_HLTH 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>PUB_HLTH 421-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>HSR 433-0</td>
<td>Health Economics and Healthcare Financing</td>
</tr>
<tr>
<td>PUB_HLTH 445-0</td>
<td>Writing and Peer Reviewing for Scientific Publication</td>
</tr>
<tr>
<td>HSR 456-0</td>
<td>Applied Qualitative Methods and Analysis for Health Researchers</td>
</tr>
<tr>
<td>HSR 460-0</td>
<td>Ethical Issues in Health Services Research</td>
</tr>
<tr>
<td>HSR 461-0</td>
<td>Topics in Health Services Research: Methods &amp; Measurement</td>
</tr>
<tr>
<td>HSR 462-0</td>
<td>Topics in Health Services Research: Grant Writing</td>
</tr>
<tr>
<td>HSR 500-0</td>
<td>Capstone Project</td>
</tr>
</tbody>
</table>

One Elective

- PUB_HLTH 323-0 | Health Equity |
- HSR 470-0 | Federal Policy Making and Health Care Reform |
- PUB_HLTH 431-0 | Basic Decision Analysis and Models of Medical Decision Making |
- PUB_HLTH 438-0 | Survey Design & Methodology |
- HSIP 401-0 | Introduction to Health Measurement Science |

A student may substitute other electives upon consultation with his or her program adviser.

Healthcare Quality and Patient Safety

Degree Types: MS, MD/MS

The Master’s program in Healthcare Quality and Patient Safety is designed to meet educational goals while allowing students to continue their careers or medical education, making the program accessible to medical students, clinicians, and working healthcare professionals. This program is designed for both clinical and non-clinical healthcare professionals who want to focus their career development on these important areas in health care. This 2-year, part-time program can be pursued by those living outside the Chicago area. Students travel to Northwestern University’s Chicago or Evanston campuses for the classroom-based intensive sessions and complete the Capstone project remotely.

The program focuses on the knowledge, skills, and methods required for improving the systems of healthcare delivery. The topics covered include: healthcare quality context and measurement, changing systems of care delivery and healthcare redesign, healthcare disparities, accountability and public policy, safety interventions and practices, health information technology, simulation and the science of teamwork, human factors, risk assessment methods, governance, and application of leadership skills. Additionally, students learn about the external environment that shapes health policy, particularly with regard to quality and safety.

The Master of Science degree program includes nine courses and begins during the summer quarter. The core of the program consists of four, 5-day Immersion sessions, held in-person at the Chicago or Evanston campuses. In addition to these high-contact sessions, six courses enrich Immersion coursework through distance learning sessions held remotely. Synchronous, distance learning sessions for each applicable course are held one evening per week following Immersion Sessions. The nine course curriculum covers introductory topics in healthcare quality and patient safety, advanced topics in healthcare quality and patient safety, an introduction to US health systems, and fundamental methods for healthcare quality and patient safety. The curriculum also includes a business course—The Business of Quality and Safety Improvement—taught by distinguished faculty from Northwestern’s Kellogg School of Management. The Master’s program concludes with a two-quarter mentored Capstone project, in which students design, implement, and evaluate a quality or safety improvement project in their home organization and receive feedback and mentoring through group mentored sessions.

After completing this Master of Science degree, graduates will have acquired the necessary skills and knowledge to be competitive for leadership positions in healthcare and research institutions, governmental and policy bodies, and careers in academia. Graduates will be well prepared to be leaders in the next generation of quality and safety specialists, designing and implementing quality and safety initiatives across health care plans, hospitals, state and federal agencies, and voluntary organizations throughout the country.

Degrees Offered

- Healthcare Quality and Patient Safety MS (p. 71)
- Healthcare Quality and Patient Safety MS/MD (p. 71)

Healthcare Quality and Patient Safety MS/MD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Medical students currently enrolled in the Doctor of Medicine program at Feinberg School of Medicine (https://www.feinberg.northwestern.edu/md-education) may apply for the combined MD/MS program. The MS program is completed part-time and can be completed in the first two years of medical school while allowing students to continue their medical education. Coursework can assist students with the (https://www.feinberg.northwestern.edu/md-education/education/curriculum/components/learning-strategies/area-scholarly-concentration) Area of Scholarly Concentration (https://www.feinberg.northwestern.edu/md-education/education/curriculum/components/learning-strategies/area-scholarly-concentration) requirement at Feinberg.

Master of Science

Total Units Required: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQS 401-0</td>
<td>Introduction to Healthcare Quality</td>
</tr>
<tr>
<td>HQS 402-0</td>
<td>Introduction to Patient Safety</td>
</tr>
<tr>
<td>HQS 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>HQS 440-0</td>
<td>Fundamental Methods for Healthcare Quality and Patient Safety</td>
</tr>
<tr>
<td>HQS 510-0</td>
<td>The Business of Healthcare Quality and Safety Improvement</td>
</tr>
<tr>
<td>HQS 501-0</td>
<td>Advanced Healthcare Quality</td>
</tr>
<tr>
<td>HQS 502-0</td>
<td>Advanced Patient Safety</td>
</tr>
<tr>
<td>HQS 430-0</td>
<td>Capstone Class I</td>
</tr>
<tr>
<td>HQS 435-0</td>
<td>Capstone Class II</td>
</tr>
</tbody>
</table>

Healthcare Quality and Patient Safety MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master of Science

Total Units Required: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQS 401-0</td>
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</tr>
<tr>
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<td>The Business of Healthcare Quality and Safety Improvement</td>
</tr>
<tr>
<td>HQS 501-0</td>
<td>Advanced Healthcare Quality</td>
</tr>
<tr>
<td>HQS 502-0</td>
<td>Advanced Patient Safety</td>
</tr>
</tbody>
</table>
### History

**https://www.history.northwestern.edu/**

**Degree Types:** PhD

The PhD Program in History (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#field) prepares students for careers as teachers and scholars. It is designed to help students achieve a comprehensive grasp of historical fields and processes, develop critical skills in respect to sources, texts, genres, theory, and methods of inquiry, and carry out original research that makes a significant contribution to historical study.

The program is distinguished by its relatively compact size, admitting about 15 students each year. This highly selective program allows close faculty-student interaction and permits exacting criticism of sources, research procedures, and writing skills.

Each student’s course of study revolves around a chosen general field, minor field, and specialization field. The program encourages students to acquire a frame of reference for their research based on grounding in geographical and cross-disciplinary fields outside their specializations.

Students in this program are encouraged to participate in TGS’s Interdisciplinary Cluster Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program please visit the Interdisciplinary Cluster Initiative page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).

### Degrees Offered

- History PhD (p. 72)

### History PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

The History Department does not offer a separate master’s program. Students in the PhD program earn a master’s degree after a year of satisfactory work toward the PhD degree. Northwestern’s School of Professional Studies (https://sps.northwestern.edu) offers several part-time master’s programs, including the Master of Arts in Liberal Studies (MALS) and a Master of Arts in Literature (MALit).

**PhD**

**Total Units Required:** 18

The principal formal requirements for the PhD in history are as follows:

- Completion of 18 courses during the first two years of study, including two quarters of work each year in an intensive research seminar.
- Passing of examinations in three areas (a general field (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#generalfield), a specialization (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#specialization) within that field, and a minor field (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#minorfield)) during the second and third year of study.
- Demonstration of proficiency in the primary research language (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#language).
- Submission of a dissertation prospectus (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#dissertation) or proposal by the end of the third year of study.
- Demonstration of proficiency in additional languages (https://www.history.northwestern.edu/graduate/current-students/degree-requirements.html#language) as necessary.
- Presentation of an approved dissertation.
- Completion of HISTORY 560-0 Teaching History by the end of the fifth year.

### Human Development and Social Policy

**http://www.sesp.northwestern.edu/hdsp/**

**Degree Types:** PhD

The Human Development and Social Policy Program (HDSP) (https://www.sesp.northwestern.edu/hdsp) studies how public policy affects human development and well-being, how research on human development across the life span informs policy, and how people affect policy.

The core curriculum in HDSP provides interdisciplinary training in human development, qualitative and quantitative methods, and policy development, implementation, and evaluation. Students then specialize in areas such as child development and social policy, adult development and social policy, or human development and education policy.

Depending on their specializations, students receive training for academic positions in basic departments such as psychology, sociology or economics and for multidisciplinary programs such as human development, education, social ecology, public health and family studies. Graduates are also strongly qualified for positions in private and nonprofit social research firms and for government research or policy positions.

### Degrees Offered

- Human Development and Social Policy Program PhD (p. 72)

### Human Development and Social Policy Program PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

There is no terminal degree in Human Development and Social Policy. Students pursuing the PhD may receive the MA as part of their doctoral
course of study at their discretion; those leaving the program prior to the completion through to earning the PhD may receive the MA if they qualify.

**Total Units Required: 13**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDSP Proseminar (1 unit)</td>
<td>Proseminar in Human Development and Social Policy I</td>
</tr>
<tr>
<td>Foundations of Human Development (4 units)</td>
<td>Theories of Human Development</td>
</tr>
<tr>
<td>Three of the four following courses:</td>
<td></td>
</tr>
<tr>
<td>HDSP 402-0</td>
<td>Child Development and Social Policy</td>
</tr>
<tr>
<td>HDSP 403-0</td>
<td>Adolescent Development</td>
</tr>
<tr>
<td>HDSP 404-0</td>
<td>Adult Development and Aging</td>
</tr>
<tr>
<td>HDSP 415-0</td>
<td>Nature vs. Nurture Revisited</td>
</tr>
</tbody>
</table>

Group IV

<table>
<thead>
<tr>
<th>Foundations in Empirical Research Methods (4 units)</th>
<th>Quantitative Methods I: Probability and Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDSP 410-0</td>
<td>Quantitative Methods II: Regression Analysis</td>
</tr>
<tr>
<td>HDSP 412-0</td>
<td>Quantitative Methods III: Empirical Tools for Causal Quantitative Analysis</td>
</tr>
<tr>
<td>HDSP 432-0</td>
<td>Field Methods</td>
</tr>
</tbody>
</table>

**Foundations of Social Policy (4 units)**

Students must take one course from each of the following groups:

**Group I**

| HDSP 430-0 | Economics of Social Policy |

**Group II**

| HDSP 429-0 | Social-Community Interventions |
| HDSP 451-0 | Topics in Human Development & Soc Policy (Organizations, Institutions and Society: Persistence and Change Among Public, Private and Non-Profit Sectors) |

**Group III**

| HDSP 428-0 | Education Policy: Design, Implementation and Effects |
| HDSP 427-0 | Sociology of Education |

**Group IV**

| HDSP 433-0 | Modern Theories of the State and Social Policy |
| HDSP 442-0 | Social Policymaking and Policy Implementation |

**Other MA Degree Requirements**

- **Examinations**: none specified
- **Research/Projects**: see master’s thesis below
- **Master’s Thesis (HDSP Trial Research)**: The Trial Research addresses questions that can be answered through empirical, feasible investigations (please note that neither a critical review of the literature on a topic, nor a speculative essay, is acceptable). The final paper should include the student’s particular
  a. research questions
  b. conceptual framework and review of prior literature
  c. methods of data collection
  d. results, and
  e. discussion, conclusions, interpretations, and suggestions for further research.

**PhD**

HDSP Curriculum Overview To obtain a PhD in Human Development and Social Policy (HDSP), students entering the program without master’s degrees must complete 27 courses, including the core curriculum and electives, a trial research and an annotated course outline. Those students entering the program with a master’s degree may petition the Program Chair to receive up to nine elective course waivers, which could potentially reduce the required course number to 18 courses, including the core curriculum and remaining 4 electives. There are no qualifying examinations. Instead, successful completion of the Trial Research and The Guided Literature Review OR Course Outline admits a student to PhD candidacy. There is a two quarter teaching requirement to serve as a teaching assistant. The last requirement for the degree is completion of a dissertation.

**Total Units Required: 13**

<table>
<thead>
<tr>
<th>Course</th>
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</tr>
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<tbody>
<tr>
<td>HDSP Proseminar (1 unit)</td>
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Group IV

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</table>

**Foundations of Social Policy (4 units)**

Students must take one course from each of the following groups:

**Group I**

| HDSP 430-0 | Economics of Social Policy |

**Group II**

| HDSP 429-0 | Social-Community Interventions |
| HDSP 451-0 | Topics in Human Development & Soc Policy (Organizations, Institutions and Society: Persistence and Change Among Public, Private and Non-Profit Sectors) |

**Group III**

| HDSP 428-0 | Education Policy: Design, Implementation and Effects |
| HDSP 427-0 | Sociology of Education |

**Group IV**

| HDSP 433-0 | Modern Theories of the State and Social Policy |
| HDSP 440-0 | The Politics of Public Policy |

**Industrial Engineering and Management Sciences**

https://www.mccormick.northwestern.edu/industrial/

Degree Types: PhD

The Industrial Engineering and Management Sciences PhD Program (https://www.mccormick.northwestern.edu/industrial/phd-program) produces researchers who combine strength in core methodologies of operations research (e.g., optimization, stochastic modeling and simulation, statistics, and data analytics) with the ability to apply them to yield practical benefits in solving problems that are important in the real world. The program offers students the opportunity to use skills
in computing, mathematical analysis and modeling, and economics to produce research that helps to improve the efficiency, quality, and the potential of organizations to fulfill their missions. The program prepares students for research-based careers in industry, academia, non-profit, and government.


Applicants must have a bachelor’s or master’s degree in a relevant discipline, but need not have a degree in industrial engineering. The program has attracted students of applied mathematics, computer science, economics, finance, mathematics, physics, statistics, and most other engineering disciplines.

Degrees Offered

• Industrial Engineering and Management Sciences PhD (p. 74)

Industrial Engineering and Management Sciences PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Those students enrolled in the IEMS PhD program receive the MS as they progress toward the PhD. For students who are progressing to the PhD, the master’s degree is generally awarded upon completion of the following:

Total Units Required: 12

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEMS 401-0</td>
<td>Applied Mathematical Statistics</td>
</tr>
<tr>
<td>IEMS 435-0</td>
<td>Stochastic Simulation</td>
</tr>
<tr>
<td>IEMS 450-1</td>
<td>Mathematical Optimization I</td>
</tr>
<tr>
<td>IEMS 450-2</td>
<td>Mathematical Optimization II</td>
</tr>
<tr>
<td>IEMS 460-1</td>
<td>Stochastic Processes I</td>
</tr>
<tr>
<td>OPNS 516-0</td>
<td>Stochastic Foundations</td>
</tr>
</tbody>
</table>

Electives (6)

Other MS Degree Requirements

• Examination on a research paper at end of first year

PhD

Total Units Required: 17

<table>
<thead>
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<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
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<td>IEMS 401-0</td>
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</tr>
<tr>
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<td>Stochastic Processes I</td>
</tr>
<tr>
<td>OPNS 516-0</td>
<td>Stochastic Foundations</td>
</tr>
</tbody>
</table>

Other Required Courses

IEMS 481-0 Logistic
IEMS 482-0 Operations

Program of Coursework

Courses in major area (at least four)
Courses in two minor areas (two each)
IEMS 4xx Elective Course

Other PhD Degree Requirements

• Examinations: candidacy examination on a research paper at end of first year
• Prospectus: Initial part of dissertation research, to be completed by the end of the third year in the program.
• PhD Dissertation: based on independent research
• Final Evaluations: oral defense of dissertation
• Other: at least one experience as an instructor or teaching assistant; satisfy TGS English proficiency requirement

Interdisciplinary Biological Sciences Program

https://www.ibis.northwestern.edu/

Degree Types: PhD

The Interdisciplinary Biological Sciences (IBiS) Program (https://www.ibis.northwestern.edu) provides the resources and training environment necessary to promote the development of Ph.D. students into independent, creative research scientists and teachers. The program includes approximately 65 training faculty from diverse science and engineering departments on Northwestern’s main campus, who are linked by common interests in addressing fundamental questions in the biological and biomedical sciences.

Increasingly, the life sciences require interdisciplinary approaches in order to make essential progress in understanding normal cellular processes, diseases such as cancer, and the development of complex systems. With closely connected faculty from the departments of Molecular Biosciences, Biomedical Engineering, Neurobiology, Chemistry, and Chemical and Biological Engineering, and with strong ties to numerous interdisciplinary centers including the Physical Sciences-Oncology Center, the Center for Cell and Developmental Systems Biology, the Chemistry of Life Processes Institute, and the Center for Structural Biology, IBiS promotes innovative research that crosses traditional disciplinary boundaries.

IBiS’ participation in Northwestern’s umbrella program in Life and Biomedical Sciences provides students with even more opportunities to explore diverse research areas, develop innovative research projects, and take full advantage of all of Northwestern’s many resources. Cross-campus training clusters help provide depth of training once students have chosen an area of specialization after the first year of graduate school. These clusters serve as foci for training activities (e.g. symposia, poster sessions, journal clubs) and specialized coursework, and bring together students and faculty with common research interests from across Northwestern.

IBiS students also benefit from a close-knit scientific community, a supportive advising structure, an active and involved student organization that sponsors scientific and social activities, and a multifaceted professional development program that further prepares
them for a broad range of post-degree career options in academia, industry, teaching and other areas.

Degrees Offered

• Interdisciplinary Biological Sciences Program PhD (p. 75)

Interdisciplinary Biological Sciences Program PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Total Units Required: 9

Required Courses

• Core courses: 4
• Electives or additional core courses: 4
• IBIS 432-0 Statistics for Life Sciences

Non-credit Required Courses

• IBIS 421-0 Rigor & Reproducibility in Research
• IBIS 423-0 Ethics in Biological Research

Other PhD Degree Requirements

• Examinations: qualifying examination during second year of study
• Research/Projects: laboratory research based on dissertation proposal
• PhD Dissertation: written dissertation; annual presentation of research-in-progress to thesis committee
• Final Evaluations: defense consisting of written dissertation, oral defense of dissertation to thesis committee, and public presentation of research accomplishments
• Publication: acceptance of at least one first-author data paper before defense
• Teaching: two quarters as a teaching assistant
• Other: three laboratory rotations in first year, intended to assist student in selecting thesis advisor; regular participation in seminars, journal clubs, and annual scientific retreat

JD/PhD Combined Degree Program

http://www.law.northwestern.edu/academics/degree-programs/jds/jdphd/

Degree Types: JD/PhD

Northwestern’s Graduate School and School of Law offer an integrated JD and PhD program for students interested in pursuing a career in academia or another research setting (e.g., a policy research organization) and whose teaching and research will be enriched by both the JD and PhD degrees. The JD/PhD Combined Degree Program (http://www.law.northwestern.edu/academics/degree-programs/jds/jdphd) prepares students to conduct innovative research on law at the cross section of disciplines. Recognizing that a growing trend among top law schools is to hire faculty who have PhDs as well as law degrees, Northwestern offers the most efficient, cohesive, and affordable option for future academics wishing to pursue their doctoral and law degrees simultaneously.

The program’s curriculum allows students to complete both degrees more efficiently than they would through consecutive degree programs. Students can complete the entire program (including dissertation) in as few as six years, depending on the requirements of the particular PhD program.

Students can select a doctoral program in any discipline, provided they can incorporate their interest in law with their graduate research and they can complete a dissertation that draws on both disciplines.

Application to the JD/PhD program requires acceptance into both The Graduate School and the Law School.

Degrees Offered

• JD/PhD Combined Degree (https://catalogs.northwestern.edu/law/programs/jd/options/jdphd)

Learning Sciences

https://www.sesp.northwestern.edu/learning-sciences/index.html

Degree Types: PhD, MA

The Interdisciplinary Learning Sciences Program (https://www.sesp.northwestern.edu/learning-sciences) prepares researchers, developers, and practitioners to advance the scientific understanding and practice of teaching and learning.

Through coursework and research apprenticeships, students engage in three facets of learning sciences research and theory:

• Cognition: Scientific models of the structures and processes of learning and teaching.
• Sociocultural context: Social, organizational, and cultural dynamics of learning and teaching.
• Design: Building environments for learning and teaching.

Students participate in frontier investigations in schools, workplaces, and other settings. The program emphasizes the design and use of technologies as a component of innovation and educational reform.

Learning Sciences faculty consider learning and teaching from a diversity of theoretical and methodological perspectives including artificial intelligence, cognitive and developmental psychology, computer science, and educational research.

Degrees Offered

• Learning Sciences MA (p. 75)
• Learning Sciences PhD (p. 76)

Learning Sciences MA

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Total Units Required: 9
Learning Sciences PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: 15

Course | Title
--- | ---
Required courses:  
LRN_SCI 401-0 | Knowledge Representation for the Learning Sciences  
LRN_SCI 402-0 | Social Dimensions of Teaching & Learning  
LRN_SCI 403-0 | Foundations of the Learning Science  
LRN_SCI 405-2 | What's the System in Educational Systems  
LRN_SCI 425-0 | Introduction to Design for the Learning Sciences  
LRN_SCI 429-0 | Design of Learning Environments  
LRN_SCI 451-0 | Topics in Learning Sciences (Field Methods)  
LRN_SCI 451-0 | Topics in Learning Sciences (Advanced Qualitative Methods)  
LRN_SCI 451-0 | Topics in Learning Sciences (Quantitative Methods 1)  
LRN_SCI 451-0 | Topics in Learning Sciences (Quantitative Methods 2)  

Two of the following courses:  
LRN_SCI 426-0 | Design of Technological Tools for Thinking and Learning  
LRN_SCI 429-0 | Design of Learning Environments  
COMP_SCI 430-0 | Design of Interactive Learning Environments  
COMP_SCI 472-0 | Designing & Constructing Models with Multi-Agent Language

Program seminars or University graduate-level courses (5)

Other PhD Degree Requirements  
- Examinations: written qualifying exam taken during summer after second year
- Research/Projects: research presentation and paper after second year; pre-dissertation research project
- Teaching: serve as teaching assistant for at least two courses  
- PhD Dissertation: based upon independent research  
- Final Evaluations: oral defense of dissertation research

Life Sciences and Clinical Investigation Dual Degree

https://www.feinberg.northwestern.edu/sites/dgp/index.html

Degree Types: MS/PhD

The Driskill Graduate Program in the Life Sciences (DGP) and the Master of Science in Clinical Investigation (MSCI) is dual degree program leading to the PhD and MS degrees. The DGP/MS degree, leverages CTSA and NUCATS Institute resources to extend integrated clinical/translational research training to DGP PhD students. This dual degree is designed to connect PhD trainees in life sciences early in their research experience with clinician investigators who can help them see the value of understanding the clinical needs of patients. These DGP/MS trainees will have a more informed perspective on the intersection between translational and clinical research. They are positioned to become bi-directional collaborators and innovators in this critical space.

Graduates of this program will be uniquely positioned to work in multidisciplinary teams in academic, corporate or government positions to accelerate the translation of research discoveries that improve human health.

Degrees Offered
- Life Sciences and Clinical Investigation Dual Degree MS/PhD

(p. 76)

Life Sciences and Clinical Investigation Dual Degree MS/PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD/MS
Total Units Required for the combined PhD/MS Degree: 12

Courses Required by DGP for PhD Component
Total DGP courses: 6

Course | Title
--- | ---
Core Courses  
Biochemistry, Molecular Biology, Cell Biology, Statistics (4 units)

Elective Courses  
Two DGP electives of the student's choice in consultation with their adviser(s)

Courses Required by Clinical Investigation for the MS Component
Total MSCI courses: 6

Course | Title
--- | ---
Core Courses  
MSCI 321-1 | Biostatistics for Clinical Investigators 1
Life Sciences and Public Health Dual Degree PhD/MPH

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD/MPH

Total Units Required for the combined PhD/MPH Degree: 20

Courses Required by DGP for PhD Component
Total DGP courses: 6

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td></td>
</tr>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>PUB_HLTH 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>PUB_HLTH 303-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>PUB_HLTH 304-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 310-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 311-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 312-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 410-0</td>
<td>Field Experience in Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 560-0</td>
<td>Culminating Experience</td>
</tr>
</tbody>
</table>

Intermediate Level Course Requirement

One of the following:

- PUB_HLTH 421-0 Intermediate Biostatistics
- PUB_HLTH 422-0 Intermediate Epidemiology

Methodology Course Requirement

One of the following:

- PUB_HLTH 416-0 Program Evaluation
- PUB_HLTH 425-0 Introduction to GIS and Spatial Analysis for Public Health
- PUB_HLTH 431-0 Basic Decision Analysis and Models of Medical Decision Making
- PUB_HLTH 435-0 Health Services Research Design & Analysis Strategies: Technology Assessment
- PUB_HLTH 438-0 Survey Design & Methodology
- PUB_HLTH 439-0 Qualitative Research Methods
- PUB_HLTH 446-0 Design, Conduct & Analysis of Clinical Trials

Electives

Two of the following:

- PUB_HLTH 420-0 Molecular Mechanisms of Carcinogenesis
- PUB_HLTH 421-0 Advanced Microbial Pathogenesis
- PUB_HLTH 422-0 Advanced Immunology
- PUB_HLTH 423-0 Microbiology
- PUB_HLTH 424-0 Virology

Life Sciences and Public Health Dual Degree

https://www.feinberg.northwestern.edu/sites/dgp/index.html

Degree Types: PhD/MPH

The Life Sciences and Public Health Combined PhD/MPH Program (https://www.feinberg.northwestern.edu/sites/dgp) focuses on scientific research and interdisciplinary public health. Graduates of this program will be positioned for leadership roles in academic and government institutions seeking expertise in molecular or cellular approaches to population-based health questions.

Students typically conduct thesis research in the basic mechanisms of infectious diseases or cancer biology. These areas play an increasingly important role in the emerging specialization of molecular epidemiology. Other areas of research, however, are available to dual-degree students.

Applicants wishing to apply to the combined PhD/MPH degree program will do so by selecting L21PH from the application pull-down menu. Applicants should include their intention in their personal statement.

The PhD/MPH program will also accept applications from first-year Driskill Graduate Program in Life Sciences (DGP) students who did not seek admission to the combined degree program before matriculation. Successful applicants will demonstrate exceptional academic potential, indicative of an ability to master the additional course load required of the combined degree. The DGP and MPH admissions committees make admission decisions jointly.

Degrees Offered

- Life Sciences and Public Health Dual Degree PhD/MPH (p. 77)
After receiving training in basic linguistic theory, students have considerable flexibility in designing their own courses of study. We encourage students to pursue research topics that span more than one subfield of linguistics.

The active involvement of over 20 affiliated faculty (https://www.linguistics.northwestern.edu/people/affiliated-faculty) in other departments and schools provides a wide range of interdisciplinary opportunities (https://www.linguistics.northwestern.edu/graduate/interdisciplinary-programs) including courses, colloquia, and research involvement.

Degrees Offered
- Linguistics PhD (p. 78)

Linguistics PhD
Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 14

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING 370-0</td>
<td>Fundamentals of Meaning</td>
</tr>
<tr>
<td>LING 372-0</td>
<td>Pragmatics</td>
</tr>
<tr>
<td>LING 470-1</td>
<td>Semantic Analysis I</td>
</tr>
</tbody>
</table>

Sound Structure

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING 350-0</td>
<td>Fundamentals of Laboratory Phonology</td>
</tr>
<tr>
<td>LING 450-1</td>
<td>Laboratory Phonology I</td>
</tr>
<tr>
<td>LING 450-2</td>
<td>Laboratory Phonology II</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING 360-0</td>
<td>Fundamentals of Syntax</td>
</tr>
<tr>
<td>LING 460-1</td>
<td>Syntactic Analysis I</td>
</tr>
</tbody>
</table>

Statistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING 330-0</td>
<td>Research Methods in Linguistics</td>
</tr>
</tbody>
</table>

One additional advanced course in statistics

Computational Linguistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING 334-0</td>
<td>Introduction to Computational Linguistics</td>
</tr>
</tbody>
</table>

One additional advanced computational linguistics course

Advanced Electives

Any two Linguistics courses offered for graduate credit, excepting independent study and courses used to satisfy requirements listed above

Additional Degree Requirements
- Research/Projects: successful completion of one research paper, by the end of eighth quarter, for admission to candidacy; acceptable master’s thesis in department may be offered to satisfy requirements
- PhD Dissertation: in addition to PhD degree requirements outlined in the Graduate Study at Northwestern University section of this Web site, completion of a prospectus by the end of the twelfth quarter, for admission to candidacy
- Final Evaluations: none specified beyond the PhD degree requirements outlined in the Graduate Study at Northwestern University section of this Web site

Linguistics

https://www.linguistics.northwestern.edu/

Degree Types: PhD

The Department of Linguistics (https://www.linguistics.northwestern.edu) offers a PhD program, providing students with a solid background in linguistic theory with an emphasis on empirical and experimental methodologies.

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).
• **Other:** demonstration of advanced competence in a second natural language. (For non-native English speakers, advanced competence in English satisfies this requirement.)

**Master's**

**Total Units Required:** 9  
*The Qualifying Paper and course work can be used by PhD students to satisfy requirements for MA degree.*

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>LING 350-0</td>
<td>Fundamentals of Laboratory Phonology</td>
</tr>
<tr>
<td>LING 450-1</td>
<td>Laboratory Phonology I</td>
</tr>
<tr>
<td>LING 360-0</td>
<td>Fundamentals of Syntax</td>
</tr>
<tr>
<td>LING 460-1</td>
<td>Syntactic Analysis I</td>
</tr>
<tr>
<td>LING 370-0</td>
<td>Fundamentals of Meaning</td>
</tr>
<tr>
<td>LING 470-1</td>
<td>Semantic Analysis I</td>
</tr>
</tbody>
</table>

**Other MA Degree Requirements**

- **Examinations:** none specified
- **Research/Projects:** none specified
- **Master's Thesis:** required
- **Other:** demonstration of advanced proficiency in one non-English language (department assumes native or near-native proficiency in English)

**Management and Organizations and Sociology PhD**

**Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Requirements can also be found in the Program Guidelines for Management & Organizations & Sociology PhD students issued by the Kellogg School of Management.

**Master's**

While the goal of our doctoral program is the awarding of a PhD degree, a Master of Science (MS) degree may be awarded to currently enrolled, qualified doctoral students. Students who are continuing for a PhD degree, or students who withdraw from the PhD program, may be considered for a MS degree if they have met the following requirements: they are in good academic standing with a cumulative 3.0 GPA; they have achieved a minimum "master's pass" on the MORS preliminary exam; and they have passed both the MORS candidacy paper and Sociology's second-year paper.

**PhD**

**Total Units Required:** 18

Students are required to take 18 courses or a minimum of 3 courses in fall, winter, and spring quarters during years one and two. Registration for Independent Study (MORS 499-0 Independent Study or SOCIOL 499-0 Independent Study) with a professor may count towards the coursework requirement.

To fulfill the 18-course requirement for the PhD degree, refer to the table below. Note: the list allows students flexibility in course selection.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociological Theory</strong></td>
<td></td>
</tr>
<tr>
<td>SOCIOl 406-1</td>
<td>Classical Theory in Sociological Analysis</td>
</tr>
<tr>
<td>SOCIOl 406-2</td>
<td>Race, Gender, Du Bois &amp; Sociological Theory</td>
</tr>
<tr>
<td>SOCIOl 406-3</td>
<td>Contemporary Theory in Sociological Analysis</td>
</tr>
<tr>
<td><strong>Organizational Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>MORS 525-1</td>
<td>Behavior in Organizational Systems</td>
</tr>
<tr>
<td>MORS 525-2</td>
<td>Organizations in Their Environments</td>
</tr>
<tr>
<td><strong>Social Organization</strong></td>
<td></td>
</tr>
<tr>
<td>SOCIOl 408-0</td>
<td>Sociology of Law</td>
</tr>
<tr>
<td>SOCIOl 420-0</td>
<td>Cultural Sociology and the Sociology of Culture</td>
</tr>
<tr>
<td>SOCIOl 437-0</td>
<td>Economic Sociology</td>
</tr>
<tr>
<td>SOCIOl 439-0</td>
<td>Comparative and Historical Sociology</td>
</tr>
<tr>
<td>SOCIOl 440-0</td>
<td>Stratification, Race and Gender</td>
</tr>
<tr>
<td>SOCIOl 441-0</td>
<td>Social Movements</td>
</tr>
<tr>
<td>SOCIOl 476-0</td>
<td>Topics in Sociological Analysis (can be repeated for credit)</td>
</tr>
<tr>
<td>MORS 524-1</td>
<td>The Individual and the Organization</td>
</tr>
<tr>
<td>MORS 524-2</td>
<td>Social Processes in Organizations</td>
</tr>
</tbody>
</table>

**Method**

Two seminars:

| SOCIOl 403-0 | Field Methods |

**Management and Organizations and Sociology**

https://www.kellogg.northwestern.edu/doctoral/programs/management-organizations-sociology.aspx

**Degree Types:** PhD

Students in this joint program offered by Kellogg School of Management’s Management & Organizations (MORS) Department and Weinberg College of Arts & Sciences Sociology Department are interested in topics that bridge management strategy and economic sociology, such as social movements, the production of culture, entrepreneurship, social networks, gender and race inequality in organizations, and globalization.

Our philosophy is that intellectual and research interests come first, and that research methods should be tailored to fit research questions. Within this research framework, our program is designed to bring together those students who want a disciplinary base in sociology while focusing their research on organizations and their environments. Our students become actively involved in research during their first year of study. The Management & Organizations & Sociology program develops students’ theoretical knowledge and methodological skills for careers as successful and productive researchers within a business school or sociology department.

**Degrees Offered**

- Management and Organizations and Sociology PhD (p. 79)
innovative and high-impact research.
Research from day one; and the breadth of faculty expertise that fosters students' active involvement in scholarly systems, and management broadly defined.

The PhD program in Management and Organizations ("MORS") integrates psychological, sociological, economic, and complex systems perspectives on the study of organizations and their members. Faculty and students pursue research on the behavior of individuals, groups, organizations and groups of organizations, with the goal of advancing theoretical understanding of these phenomena. The MORS program maintains an active training program for researchers with interests in individual decision making, management and organizations, complex systems, and management broadly defined.

The hallmarks of the program are a first year curriculum that provides a broad theoretical background in the disciplines of psychology and sociology that underlies the behavior of individuals, groups, organizations and their environments; students' active involvement in scholarly research from day one; and the breadth of faculty expertise that fosters innovative and high-impact research.

Management and Organizations
https://www.kellogg.northwestern.edu/faculty/academics/management-and-organizations.aspx

Degree Types: PhD

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Requirements can also be found in the Program Guidelines for Management & Organizations PhD students issued by the Kellogg School of Management.

Master's
While the goal of our doctoral program is the awarding of a PhD degree, a Master of Science (MS) degree may be awarded to currently enrolled, qualified doctoral students. Students who are continuing for a PhD degree, or students who withdraw from the PhD program, may be considered for a MS degree if they are in good academic standing with a cumulative 3.0 GPA, and they have achieved a minimum of a "master's pass" on the preliminary exam.

PhD
Total Units Required: 18

Students are required to take 18 courses or a minimum of 3 courses in fall, winter, and spring quarters during years one and two. Required courses for the degree are listed below:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MORS 524-1</td>
<td>The Individual and the Organization</td>
</tr>
<tr>
<td>MORS 524-2</td>
<td>Social Processes in Organizations</td>
</tr>
<tr>
<td>MORS 525-1</td>
<td>Behavior in Organizational Systems</td>
</tr>
<tr>
<td>MORS 525-2</td>
<td>Organizations in Their Environments</td>
</tr>
<tr>
<td>MORS 526-1</td>
<td>Micro-Organizational Research Methods</td>
</tr>
<tr>
<td>MORS 526-2</td>
<td>Macro-Organizational Research Methods</td>
</tr>
</tbody>
</table>

To fulfill the 18-course requirement for the PhD degree, students must supplement the required coursework with approved electives. Independent Study (MORS 499-0) may also qualify. Students must maintain a minimum overall GPA of 3.0 to be in good academic standing.

Other PhD Degree Requirements

- **Examinations**: PhD preliminary exam in Management and Organizations core "macro" courses: MORS 525-1 Behavior in Organizational Systems, and MORS 526-2 Macro-Organizational Research Methods; exam is scheduled in July of the first year.
- **Research/Projects**: In years two and three students must satisfy paper requirements within MORS (candidacy paper) and Sociology (second-year paper and special fields paper), at which time the performance on the MORS prelim exam, coursework and papers is reviewed and students are passed into candidacy.
- **PhD Dissertation**: Original and significant research. Presentation of preliminary results (prospectus) to their committee by the end of the fourth year.
- **Final Evaluations**: Oral final examination on dissertation and submission of an approved dissertation.

Management and Organizations PhD

Degree Requirements

https://www.kellogg.northwestern.edu/faculty/academics/managerial-economics-decision-sciences.aspx

Degree Types: PhD

Degree Offered

- Management and Organizations PhD (p. 80)
The PhD program in Managerial Economics & Strategy (MECS), a program offered jointly by the Departments of Managerial Economics & Decision Sciences (MEDS) and Strategy, emphasizes the use of rigorous theoretical and empirical models to solve problems in both theoretical and applied economics. A distinctive feature of the program is its particular focus on methods and insights drawn from microeconomics. The program should appeal to students who wish to investigate economic questions in scenarios where the actions of individual decision makers (such as individual people, firms, or countries) play a key role in determining outcomes. The program is appropriate for students with an aptitude for analytical thinking, mathematical modeling, and formal analysis.

The MECS program produces research scholars who obtain academic positions at top economics departments and business schools throughout the world. This objective is achieved by restricting class sizes (averaging 5-6 students entering per year), accelerating students’ exposure to the development of research ideas, and by providing access to courses taught in the MEDS and Strategy Departments along with Northwestern’s Economics Department.

**Degrees Offered**

- Managerial Economics and Strategy PhD (p. 81)

## Managerial Economics and Strategy PhD

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Requirements can also be found in the Program Guidelines for Managerial Economics & Strategy PhD students issued by the Kellogg School of Management.

### Master’s

The goal of our doctoral program is the awarding of a PhD degree. En route to this goal, a Master of Science (MS) degree can be awarded to currently enrolled, qualified Kellogg doctoral students who are in good academic standing, have completed a minimum of three quarters of coursework with a cumulative 3.0 GPA, and have achieved minimum of a “master’s pass” on the preliminary ("field") exams.

### PhD

**Total Units Required: 18**

Students in the PhD program are required to take (at least) the following nine courses in their first year (at least 3 courses in each of fall, winter, and spring quarters).

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECS 560-1</td>
<td>Static Optimization in Economics</td>
</tr>
<tr>
<td>MECS 560-2</td>
<td>Dynamic Optimization in Economics</td>
</tr>
<tr>
<td>MECS 560-3</td>
<td>Research in Economics</td>
</tr>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-2</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-3</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 480-1</td>
<td>Econometrics</td>
</tr>
</tbody>
</table>

In the second year, PhD students register for a minimum of nine courses to fulfill the 18-course requirement. These nine courses must contain at least three sequences – at least two courses within the same area of study. Registration for an Independent Study (MECS 499-0 Independent Study) may count towards the coursework requirement.

### Other PhD Degree Requirements

- **Examinations:** Students at the end of year one are required to demonstrate competence in three fields: microeconomics, econometrics, and optimization. This can be done by achieving a 3.6 GPA across the course sequences, or by passing the corresponding preliminary or qualifying exam in all three fields. Once competence in these three fields is achieved, students are passed into candidacy at the end of year one.
- **Research/Projects:** Completion of a second-year research paper submitted in September prior to the beginning of year three.
- **PhD Dissertation:** Original and significant research. Topic should be selected in year three, in collaboration with the advisor or advisors; presentation of preliminary results (prospectus) to committee members no later than September 15 prior to the beginning of fourth year.
- **Final Evaluations:** Oral final examination on dissertation and submission of an approved dissertation.

## Marketing

https://www.kellogg.northwestern.edu/faculty/academics/marketing.aspx

The Kellogg Marketing doctoral program provides rigorous training in the skills required for success as a world-class marketing researcher. This is achieved via coursework, close collaboration with faculty, and intellectual exchange in a department known for its research culture.

Our program offers two different tracks in training marketing scholars: a consumer behavior track, and a quantitative marketing track. Both tracks focus on understanding the impact of marketing activity on consumers and firms. However, they differ in terms of the theories and methods used to analyze data. Consumer behavior researchers tend to focus on psychological aspects of a consumer’s decision-making process and use data collected through laboratory studies and field experiments. Quantitative marketing researchers often draw on theories of behavior from related social sciences (e.g., economics, psychology, sociology), use data from observational and archival sources and field experiments, and analyze the data using advanced statistical and econometric techniques.

### Degrees Offered

- Marketing PhD (p. 81)

## Marketing PhD

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Requirements can also be found in the Program Guidelines for Marketing PhD students issued by the Kellogg School of Management.
Master’s

While the goal of our doctoral program is the awarding of a PhD degree, a Master of Science (MS) degree may be awarded to currently enrolled, qualified doctoral students. Students who are continuing for a PhD degree, or students who withdraw from the PhD program, may be considered for a MS degree if they are in good academic standing, they have completed 10 graded doctoral courses with a cumulative 3.0 GPA, and complete and present a satisfactory first-year paper (minimum MS pass) by mid-September.

PhD

Total Units Required: 18

Students in the PhD Program are required to take 18 courses; however the required and elective courses are different based upon the research track: consumer behavior or quantitative marketing. Refer to the course tables below for each research track.

Consumer Behavior:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MKTG 531-1</td>
<td>Theory Building in Consumer Behavior Research</td>
</tr>
<tr>
<td>MKTG 531-2</td>
<td>Methods and Data in Consumer Research</td>
</tr>
<tr>
<td>MKTG 531-3</td>
<td>Developing Impactful Consumer Research</td>
</tr>
<tr>
<td>MKTG 540-0</td>
<td>Special Topics in Consumer Research</td>
</tr>
</tbody>
</table>

Special Note: Students enroll in the 4 courses listed above in years one and two.

Quantitative Marketing:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MKTG 551-1</td>
<td>Quantitative Marketing: Introduction to Theory and Empirical Methods</td>
</tr>
<tr>
<td>MKTG 551-2</td>
<td>Quantitative Marketing: Statistical Modeling</td>
</tr>
<tr>
<td>MKTG 551-3</td>
<td>Quantitative Marketing: Structural Modeling</td>
</tr>
<tr>
<td>MKTG 552-0</td>
<td>Topics in Quantitative Marketing</td>
</tr>
<tr>
<td>ECON 410-1</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 410-3</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>ECON 450-1</td>
<td>Industrial Organization</td>
</tr>
<tr>
<td>ECON 450-2</td>
<td>Industrial Organization</td>
</tr>
<tr>
<td>ECON 450-3</td>
<td>Industrial Organization</td>
</tr>
<tr>
<td>ECON 480-1</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 480-2</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 480-3</td>
<td>Econometrics</td>
</tr>
</tbody>
</table>

To fulfill the 18-course requirement, students must register for a minimum of 3 courses in fall, winter, and spring quarters during years one and two. Registration in independent study (MKTG 499-0 Independent Study) would also qualify. All elective courses must be approved. Students must maintain a minimum overall GPA of 3.0 to be in good academic standing.

Other PhD Degree Requirements

- **Examinations**: PhD qualifying exam during June of the first year.
- **Research/Projects**: Oral presentation of a research paper at the end of summer in years one and two, at which time the performance on the qualifying exam, coursework, and second-year paper are reviewed and students are passed into candidacy.
- **PhD Dissertation**: Original and significant research; topic and advisor or advisors should be selected in the second year; presentation of preliminary results (prospectus) to their committee no later than August 31 of the third year.
- **Final Evaluations**: Oral final examination on dissertation and submission of an approved dissertation.

Marriage and Family Therapy

For further information about the MSMFT Program, please visit:

https://www.family-institute.org/graduate-education/master-science-marriage-family-therapy

Degree Type: MS

The Master of Science in Marriage and Family Therapy (MSMFT) is a COAMFTE accredited terminal degree program. With this degree, following a period of post-graduate supervised practice, graduates can become licensed as a marriage and family therapist. The program is designed for students drawn to the field of mental health who have a passion for treating relationships.

The program prepares students by using a 21st century approach to therapy developed over 25 years at The Family Institute. Known as Integrative Systemic Therapy, this approach produces therapists who skillfully deliver family, couple and individual therapy. The curriculum and clinical training are informed by multi-cultural and social justice perspectives.

The program also emphasizes research. Courses are research informed and students learn to do progress research with their own cases. For students interested in pursuing a doctorate following graduation, research opportunities exist as does a thesis option.

The program includes a comprehensive 17-course curriculum and 6 quarters of an intensive clinical internship. During the internship students conduct therapy with clients in the Institute’s own clinic.

Students conduct 500 hours of therapy, including at least 400 face-to-face hours with clients, of which, at least 200 are conducted with couples and families. Students accrue up to 100 team hours planning and guiding team cases in the context of their supervision group. Students will also receive more than 250 hours of group and individual supervision.

This full-time program is completed in two years, including the summer following the first year.

The program is a partnership between The Graduate School and The Family Institute at Northwestern University (https://www.family-institute.org), a world-renowned center with 50 years of experience conducting, teaching, and researching marriage and family therapy.

Degrees Offered

- Marriage and Family Therapy MS (p. 82)

Marriage and Family Therapy MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Total Units Required: 23
Materials Science and Engineering MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Total Units Required: 12

(No financial aid available)

Course Title
Departmental courses (8 units, 5 of which must be 400-level, excluding 499)
Elective courses (4 units, including courses from other departments)

Other MS Degree Requirements

- Examinations: None
- Research/Projects: None
- Master’s Thesis: None
- Other: None

Materials Science and Engineering PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 12

(Up to 6 units credit is given for the MS degree; see departmental guide.)

Course Title
MAT_SCI 401-0 Chemical & Statistical Thermodynamics of Materials
MAT_SCI 402-0 Structure of Crystalline and Noncrystalline Materials
MAT_SCI 404-0 Imperfections in Materials
MAT_SCI 405-0 Physics of Solids
MAT_SCI 406-0 Symmetry and Mechanical Properties of Materials
MAT_SCI 408-0 Phase Transformations in Materials
GEN_ENG 519-0 Responsible Conduct for Research Training
Departmental Electives (2 units) ¹
Electives (4 units) ²

Other PhD Degree Requirements

- Examinations: preliminary evaluation based on research progress and coursework; qualifying examination emphasizing proposed dissertation research
- Research/Projects: see departmental guide
- PhD Dissertation: materials and results from supported research programs may be used for dissertation
- Final Evaluations: public oral defense of dissertation

Other MSMFT Degree Requirements

Clinical practicum involving over 500 hours of face-to-face contact with clients and more than 250 hours of group and individual supervision.

Materials Science and Engineering

https://www.mccormick.northwestern.edu/materials-science/

Degree Types: MS, PhD

Northwestern’s Department of Materials Science and Engineering (https://www.mccormick.northwestern.edu/materials-science/graduate), the world’s first academic department of its kind, offers graduate programs leading to the MS and PhD degrees in diverse areas of materials science. These areas include nanomaterials, biomaterials, electronic materials, metals, ceramics, and polymers with applications in energy, sustainability, medicine, and additive manufacturing.

Strong interdisciplinary and collaborative research is a hallmark of materials science and engineering at Northwestern. We collaborate with other engineering and science departments, the Feinberg School of Medicine, and national laboratories including nearby Argonne National Laboratory (https://www.anl.gov).

Degrees Offered

- Materials Science and Engineering MS (p. 83)
- Materials Science and Engineering PhD (p. 83)
Mathematics

https://www.math.northwestern.edu/graduate/

Degree Types: PhD

The Graduate Program in the Department of Mathematics (https://www.math.northwestern.edu/graduate) aims to develop students into productive research mathematicians. The extremely low student-faculty ratio, approximately two-to-one, allows for close relationships between students and faculty.

Department research strengths include algebra, algebraic topology, classical and modern analysis, dynamical systems, mathematical physics, partial differential equations, probability and representation theory.

The department maintains close ties with the larger community of mathematicians at Northwestern University.

Degrees Offered
- Mathematics PhD (p. 84)

Mathematics PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 21

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td></td>
</tr>
<tr>
<td>MATH 410-1</td>
<td>Analysis</td>
</tr>
<tr>
<td>&amp; MATH 410-2</td>
<td>and Analysis</td>
</tr>
<tr>
<td>&amp; MATH 410-3</td>
<td>and Introduction to Modern Analysis</td>
</tr>
<tr>
<td>MATH 440-1</td>
<td>Geometry and Topology</td>
</tr>
<tr>
<td>&amp; MATH 440-2</td>
<td>and Geometry and Topology</td>
</tr>
<tr>
<td>&amp; MATH 440-3</td>
<td>and Geometry and Topology</td>
</tr>
<tr>
<td>MATH 470-1</td>
<td>Algebra</td>
</tr>
<tr>
<td>&amp; MATH 470-2</td>
<td>and Algebra</td>
</tr>
<tr>
<td>&amp; MATH 470-3</td>
<td>and Algebra</td>
</tr>
</tbody>
</table>

Elective Courses (12 units)

Notes
- A student who has passed the qualifying exam may register for TGS 500-0 Advanced Doctoral Study as an elective course.
- A passed preliminary exam in a subject may be substituted for a course.

Other PhD Degree Requirements
- Examinations: Three written preliminary examination in the core courses of Analysis, Geometry/Topology, and Algebra; oral qualifying examination
- Research/Projects: see PhD Dissertation below
- PhD Dissertation: original, independent research
- Final Evaluations: defense of dissertation

Mechanical Engineering

https://www.mccormick.northwestern.edu/mechanical/

Degree Types: PhD, MS


We combine innovative teaching and pioneering research in a highly collaborative environment that transcends traditional academic boundaries. Graduate students are not required to follow a rigid curriculum. Each student may tailor a course of study that accommodates individual needs, talents, and interests.

Degrees Offered
- Mechanical Engineering MS (p. 84)
- Mechanical Engineering PhD (p. 85)

Mechanical Engineering MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's

Total Units Required: 12

(At least five courses excluding MECH_ENG 499-0 Projects/MECH_ENG 512-0 Seminar/MECH_ENG 590-0 Research must be 400-level)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH_ENG 499-0</td>
<td>Research (3 units)</td>
</tr>
<tr>
<td>MECH_ENG 512-0</td>
<td>Seminar (must be taken in all quarters of full-time registration)</td>
</tr>
<tr>
<td>400-level courses (5 units)</td>
<td></td>
</tr>
<tr>
<td>Departmental, MECH_ENG courses listed in graduate handbook (5 units)</td>
<td></td>
</tr>
<tr>
<td>MS Non-Thesis</td>
<td></td>
</tr>
<tr>
<td>MECH_ENG 499-0</td>
<td>Projects (independent research)</td>
</tr>
<tr>
<td>400-level courses (5 units)</td>
<td></td>
</tr>
<tr>
<td>Departmental, MECH_ENG courses listed in graduate handbook (7 units)</td>
<td></td>
</tr>
</tbody>
</table>

Other MS Degree Requirements
- Examinations: addresses research project
- Research/Projects: research report on topic of interest to both student and advisor
Mechanical Engineering PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 15

A total of fifteen (15) course units (excluding project/research units) are required towards the PhD. Nine (9) course units within this 15 course units must satisfy the MS course requirements (including breadth requirement and minimum number of ME/core courses). At least one half (1/2) of the credited course units satisfying the post-MS requirement must be 400-level or above courses.

Registration and regular attendance at the non-credit MECH_ENG 512-0 Seminar is required for all quarters. Registration for the non-credit MECH_ENG 513-0 Professional Essentials is required for one quarter within the first two years.

Other PhD Degree Requirements

- Examinations: research qualification exam and dissertation proposal exam prior to admission to candidacy
- Research/Projects: research of publishable quality, in close cooperation with faculty advisor, as basis for PhD dissertation
- PhD Dissertation: based on research projects
- Final Evaluations: oral presentation of dissertation to candidate's advisory committee

Media, Technology and Society PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's

Students who enter without a suitable master’s degree are admitted as MA/PhD students. Students admitted to the MA/PhD program complete their MA as part of their preparation for the doctorate. Students will be required to complete nine courses. Additionally, candidates shall be required to prepare a conference-quality paper under the supervision of a three person committee during the fall quarter of their second year of coursework. This paper serves as the final comprehensive examination. Students are encouraged to use the first summer following coursework to begin preparation of this paper.

PhD

Two years (six quarters) of full-time coursework beyond MA degree is required. All doctoral students are required to take two courses:

1. a proseminar (MTS 501-0 Introduction to Grad Research in MTS), in which students are introduced to a variety of interests within MTS; and
2. a second-year practicum course focused on learning how to write a publishable-quality, empirical social-scientific research paper (MTS 503-0 The Practice of Scholarship).

Not including these required courses, students must take at least four letter-graded courses offered by MTS faculty at the 400 or 500 level. Students are also required to develop methodological expertise appropriate to their interests as specified by their committee.

Other PhD Degree Requirements

- Examinations: upon completion of coursework, written and oral comprehensive examination
- Research/Projects: present a research paper or grant proposal by the end of the second year of coursework
- PhD Dissertation: based on original, independent research
- Final Evaluations: oral defense of dissertation

Medical Anthropology

Degree Types: PhD

The combined PhD/MPH Program in Medical Anthropology (https://www.anthropology.northwestern.edu/subfields/cultural/medical-anthropology.html) prepares graduates for leadership in academic and government institutions requiring expertise in biocultural approaches to the study of human health and disease. Drawing on the broader strengths of our department in political-economic analysis, global health, and human biology, Medical Anthropology at Northwestern focuses on the intersection of health with various forms of social and political inequality. The program provides rigorous interdisciplinary training linking the fields of medical anthropology and public health in both domestic and international settings.

Students pursing the combined PhD/MPH degree fulfill all requirements for both the Doctorate in Anthropology and the Master of Public Health
through a selected interdisciplinary curriculum. A full three years of credit-bearing courses (18 units) is required in addition to the PhD dissertation.

Applicants apply to the combined PhD/MPH degree program at the time they apply for admission to the graduate program in Anthropology. Current first year Anthropology students may also apply for this program.

Degrees Offered
- Medical Anthropology PhD/MPH (p. 86)

Medical Anthropology PhD/MPH

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

MPH/PhD

Total Units Required: MPH requires a total of 16 units and Anthropology PhD requires a minimum of 9 units. Three Anthropology courses can be double-counted towards the MPH. These include: (1) a methods course (either ANTHRO 386-0 Methods in Human Biology Research or ANTHRO 389-0 Ethnographic Methods and Analysis), and (2) two other elective courses from the list below.

MPH Course Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_HLTH 310-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>PUB_HLTH 304-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>PUB_HLTH 303-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>PUB_HLTH 410-0</td>
<td>Field Experience in Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 560-0</td>
<td>Culminating Experience</td>
</tr>
</tbody>
</table>

Public Health Methods Course

Choose from:
- PUB_HLTH 421-0 Intermediate Biostatistics
- PUB_HLTH 422-0 Intermediate Epidemiology

Anthropology Methods Course

Choose from:
- ANTHRO 386-0 Methods in Human Biology Research
- ANTHRO 389-0 Ethnographic Methods and Analysis

Anthropology Curriculum Shared Public Health Content

Choose 2 from:
- ANTHRO 332-0 The Anthropology of Reproduction
- ANTHRO 390-0 Topics In Anthropology (Methods in Global Health and Anthropology)
- ANTHRO 485-0 Seminar in Mind, Body, & Health
- ANTHRO 490-0 Topics in Anthropology (Seminar on Society, Biology and Health or Human Population Biology)
- ANTHRO 386-0 or ANTHRO 489-0 if not counted as Anthropology Methods Course

Public Health Electives (5 units)

PhD Course Requirements

Students are required to complete PhD course requirements (p. 29) based on chosen subfield.

Required Papers and Proposals

Students are required to complete a Second Year Qualifying Paper, an MPH Thesis, a Dissertation Proposal, and a Dissertation.

Medical Humanities and Bioethics

https://bioethics.northwestern.edu/masters/

Degree Types: MA, including established dual-degree options with an MD or an MS in Genetic Counseling

The Master of Arts in Medical Humanities & Bioethics (https://bioethics.northwestern.edu/masters) program provides a rigorous exploration of medicine and its ethical implications through the perspectives of anthropology, literature, philosophy, history, and law. Students acquire the interdisciplinary tools to develop a broader, richer understanding of medicine in society and to engage in complex ethical analysis. Graduates can apply their knowledge and skills to clinical practice, consulting, policy debates, and academic scholarship.

This interdisciplinary degree is designed for current and future professionals in medicine, law, or related fields. It can be pursued independently or as a dual-degree with an MD or MS in Genetic Counseling. Combining the MA with a JD, PhD, or other Northwestern degree may also be possible on a case-by-case basis.

The program consists of two years of course work (which can be compressed into one year), plus a master’s thesis or comprehensive exam.

Degrees Offered
- Medical Humanities and Bioethics MA (p. 86)

Medical Humanities and Bioethics MA

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master of Arts

Total Units Required: 10

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHB 401-0</td>
<td>Foundations of Bioethics</td>
</tr>
<tr>
<td>MHB 402-0</td>
<td>Medicine &amp; Law</td>
</tr>
<tr>
<td>MHB 403-0</td>
<td>The History of Medicine and Bioethics</td>
</tr>
<tr>
<td>MHB 404-0</td>
<td>Literature, Medicine, and Bioethics</td>
</tr>
<tr>
<td>MHB 405-0</td>
<td>Social Science and Medicine</td>
</tr>
<tr>
<td>MHB 406-0</td>
<td>The Practice of Bioethics</td>
</tr>
<tr>
<td>MHB 410-1</td>
<td>Special Topics in Medical Humanities and Bioethics (taken twice for 2 units total)</td>
</tr>
<tr>
<td>MHB 499-0</td>
<td>Independent Study (Tutorials in Medical Humanities &amp; Bioethics)</td>
</tr>
</tbody>
</table>

MHB Capstone Project (Thesis or Comprehensive Exam; 1 unit)
Medical Scientist Training Program
https://www.feinberg.northwestern.edu/sites/mstp/

Degree Types: MD/PhD

The Medical Scientist Training Program (https://www.feinberg.northwestern.edu/sites/mstp) (MSTP) prepares students for exciting and rewarding careers combining biomedical investigation and the practice of medicine.

This flexible program permits the efficient and natural combination of medical and scientific training for highly motivated students of superior research potential.

MSTP students typically complete two years of the medical curriculum followed by three or more years of research training. During this time, students complete a dissertation to fulfill the requirements for the PhD degree. Students then return to the medical curriculum to complete one and one-half years of hospital-based clinical clerkships.

Degrees Offered
- Medical Scientist Training Program MD/PhD (p. 87)

Medical Scientist Training Program MD/PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

MD/PhD

MD Coursework Requirements

Students must meet coursework and clerkship requirements of Feinberg. MSTP students may receive 12 weeks of credit towards the MD elective requirements from their PhD dissertation research.

PhD Coursework Requirements

The PhD degree requirements of the graduate program in which the student is enrolled (Driskill Graduate Program in Life Sciences, Interdisciplinary Biological Sciences Program, Northwestern University Interdepartmental Neuroscience PhD Program, Biomedical Engineering Program, Department of Chemistry, Department of Material Science and Engineering, or Department of Chemical and Biological Engineering), generally involving three or more years of research training and dissertation preparation, must be met. MSTP students are required to take at least three to nine graduate-level courses for a grade during their enrollment in The Graduate School depending on the program the student has joined.

Other MD/PhD Degree Requirements
- Examinations: graduate qualifying examinations for admission to candidacy
- Research/Projects: thesis research
- PhD Dissertation: original, independent research presented in a defensible thesis of high quality
- Final Evaluations: defense of dissertation
- Publish: a minimum of one first-authored peer-reviewed research article
- Other: regular participation in MSTP Colleges Curriculum and MSTP Grand Rounds in all years; teaching assignment required by PhD programs

Medicine and Public Health

Degree Types: MD/MPH

The combined MD/MPH degree is available to incoming medical students in the Feinberg School of Medicine. Students in the combined degree program can earn both the MD and MPH degrees in four years.

The program is designed for students seeking:
- A broad perspective on the definition of health, highlighting the concepts of prevention, health promotion, health care organization and delivery, and population-based research and intervention.
- An interdisciplinary public health knowledge base derived from biomedical and social scientific theories and empiric evidence.
- The quantitative, educational, organizational, and practical skills for success in future public health practice, teaching, and/or research endeavors.

Degrees Offered
- Medicine and Public Health MD/MPH (p. 87)

Medicine and Public Health MD/MPH

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

MD/MPH

Total Units Required: 11

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core and Required Courses</td>
<td></td>
</tr>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>PUB_HLTH 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>PUB_HLTH 303-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>PUB_HLTH 310-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 311-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 312-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>PUB_HLTH 418-0</td>
<td>Applied Practice Experience I</td>
</tr>
<tr>
<td>PUB_HLTH 419-0</td>
<td>Applied Practice Experience II</td>
</tr>
<tr>
<td>PUB_HLTH 560-0</td>
<td>Culminating Experience</td>
</tr>
<tr>
<td>Intermediate Level Course Requirement</td>
<td></td>
</tr>
<tr>
<td>PUB_HLTH 421-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>or PUB_HLTH 422-0</td>
<td>Intermediate Epidemiology</td>
</tr>
</tbody>
</table>

Methodology Requirement

One of the following courses in addition to one of the intermediate level courses listed above:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_HLTH 421-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>PUB_HLTH 422-0</td>
<td>Intermediate Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 425-0</td>
<td>Introduction to GIS and Spatial Analysis for Public Health</td>
</tr>
</tbody>
</table>
Music

https://www.music.northwestern.edu/academics/degrees

Degree Types: PhD

Students admitted to the PhD Program in Music (https://www.music.northwestern.edu/academics/degrees) pursue academic coursework and write a dissertation in one of four specializations:

- Composition & Music Technology
- Music Education
- Musicology
- Music Theory & Cognition

Students in this program work closely with faculty to develop a course of study incorporating their individual interests within the context of a broad-based approach to contemporary musical research and practice. The curriculum of each specialization is structured to take full advantage of the many and varied academic opportunities available within the Bienen School of Music and The Graduate School.

A distinctive aspect of this program is the requirement of a cognate area of study in a non-music field within The Graduate School. Students also gain teaching experience at diverse levels. Through participation in program colloquia, students engage with current disciplinary issues and external scholars.

Students entering the program with a master's degree in their area of specialization normally require two years of full-time study to complete coursework. Students entering with a bachelor's degree require three.

Music PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's

The MA in Music is a non-admitting degree from The Graduate School (https://www.tgs.northwestern.edu) offered in the four specializations of the PhD program in Music (Composition & Music Technology, Music Education, Musicology, and Music Theory & Cognition). A student may request this degree only if they do not already hold a master's level degree in the field of specialization at the time of the request. Students may apply for the MA in Music after completing fifteen units toward the PhD coursework and:

- in Musicology, one foreign language exam and either two components of the qualifying exam or the dissertation prospectus
- in Music Education, the teaching demonstration and the qualifying exam
- in Music Theory & Cognition, one component of the qualifying exam or the dissertation prospectus

The MA in Music is not to be confused with the various stand-alone MM (Master of Music) degrees offered by the Bienen School of Music (https://www.music.northwestern.edu/academics/degrees). The MA in Music is only available to students already admitted to and pursuing the PhD in Music.

PhD

Specializations of study are offered in four areas: Composition & Music Technology, Music Education, Musicology, and Music Theory & Cognition. Requirements vary by area of specialization. All PhD students in Music must complete a minimum of 18 graduate units; those entering without a master's degree complete 27. Normally this requires two years of coursework in the former case and three years in the latter.

Students should consult the Bienen School of Music Graduate Handbook (https://www.music.northwestern.edu/resources/students/graduate) regarding specific curricular and qualifying exam requirements for their area of specialization.

Cognate Area of Study: In addition to completing the core, all students will be required to take three 300- or 400-level graduate courses outside the Bienen School of Music in an approved cognate area.

Colloquium: All students in residency are expected to attend and participate in the program colloquium or center in their field of specialization.

Total Course Units Required: 18-27

Other PhD Degree Requirements

- Examinations: Requirements for the Qualifying Examination include written and oral components. Specific requirements vary by specialization and are enumerated in the Bienen School of Music Graduate Handbook (https://www.music.northwestern.edu/resources/students/graduate).
- Language Requirement: Examinations in two languages (musicology specialization only)
- PhD Dissertation: Based on original, independent research. The dissertation requirement for Composition and Music Technology also includes a Doctoral Composition.
- Final Evaluations: Defense of dissertation

Neurobiology

https://www.neurobiology.northwestern.edu/

Degree Types: MS

The master's program in Neurobiology (https://www.neurobiology.northwestern.edu/graduate) features independent, hands-on research training combined with focused classroom instruction to prepare students for careers in medicine, industry, academic research,
Degrees Offered

- Neurobiology MS (p. 89)

Neurobiology MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's

Total Units Required: 9

The master's program in Neurobiology gives students the opportunity to earn a graduate degree after one year of intensive study and research. The curriculum provides focused classroom instruction and independent hands-on research training.

The master's curricular & degree requirements provide students with the training and experience to become skilled and competent leaders in their chosen career path—medicine, industry, academic research, or teaching. Students must take a minimum of 9 credits, as shown below. All students take NUIN 401-3 Fundamentals of Neuroscience (2 credits in the winter quarter) and NUIN 595-0 Master's in Science (2 credits in the winter quarter) and NUIN 595-0 Master's in Science (2 credits in the winter quarter). In the fall and spring quarters, students select an elective (1-2 credits) to complete their curricular requirements. In addition, students must present an oral thesis proposal and defense, and a written thesis document.

Other MS Degree Requirements

- **Research/Projects:** Experimental work carried out under the direction of a Neurobiology faculty member (Faculty Advisor).
- **Thesis Proposal:** A verbal presentation of proposed experimental work that will comprise the master's thesis.
- **Thesis Defense:** A verbal presentation of the experimental work that comprises the master's thesis.
- **Master's Thesis:** A written document that explains the rational, methods, data, and results of the experimental work completed under the direction of the Faculty Advisor.

Northwestern University

Interdepartmental Neuroscience Program (NUIN)

http://www.nuin.northwestern.edu/

Degree Types: PhD

Northwestern University Interdepartmental Neuroscience Program (http://www.nuin.northwestern.edu) (NUIN) is a highly interactive and collaborative program, with faculty distributed across more than 20 departments on the Lincoln Park, Chicago and Evanston campuses. Our program encourages interdisciplinary neuroscience research among seven NU-affiliated centers, including the Children’s Memorial Research Center (Lincoln Park), the Feinberg School of Medicine and Rehabilitation Institute of Chicago (Chicago), the Weinberg College of Arts and Sciences, the McCormick School of Engineering, the School of Communication and the Kellogg School of Management (Evanston). NUIN faculty pursue a broad range of research interests including molecular and developmental neuroscience, cellular physiology, cognition and systems neuroscience, and medical or ‘translational’ research. Training in research is supplemented with core and elective coursework, mentorship, teaching and other professional development opportunities.

This program attracts applicants from a broad array of academic backgrounds, including neuroscience, biology, computer science, chemistry, engineering, physics, and psychology. Our curriculum is designed to embrace this diversity while also providing intensive training in fundamental principles of neuroscience.

Degrees Offered

- Interdepartmental Neuroscience Program (NUIN) PhD (p. 89)

Interdepartmental Neuroscience Program (NUIN) PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUIN 401-1 (Fundamentals of Neuroscience (2 units))</td>
<td></td>
</tr>
<tr>
<td>NUIN 401-2 (Fundamentals of Neuroscience)</td>
<td></td>
</tr>
<tr>
<td>NUIN 401-3 (Fundamentals of Neuroscience)</td>
<td></td>
</tr>
<tr>
<td>NUIN 411-1 (Great Experiments in Molecular and Developmental Neuro Science)</td>
<td></td>
</tr>
<tr>
<td>NUIN 411-2 (Great Experiments in Cellular Neurophysiology)</td>
<td></td>
</tr>
<tr>
<td>NUIN 411-3 (Great Expts in System &amp; Cognitive Neuroscience)</td>
<td></td>
</tr>
</tbody>
</table>
The program is intentionally small so that students can work using an apprenticeship model with at least one, and often several, of our faculty, whom are active in research.

The program aims to produce scholars who can be successful in both business and engineering schools. This is accomplished through both coursework and working closely with faculty on research projects. The program seeks to enable students to evaluate both strategic issues of designing operations and tactical issues of executing processes. The faculty embraces a wide variety of research methods so students are capable of applying the tools that are most appropriate for the problem at hand.

Thoughtful design and execution of operations is critical to the success of any enterprise. The Operations Management doctoral program equips students to evaluate both strategic issues of designing operations as well as tactical issues of executing processes. The faculty embraces a wide variety of research methods so students are capable of applying the tools that are most appropriate for the problem at hand.

Operations PhD students are also required to take one MBA course at the Kellogg School of Management: either OPNS 430, “Operations Management,” or OPNS 440, “Designing and Management Business Processes.”

To fulfill the 24-course requirement for the PhD degree, students must take at least 13 approved electives, which may include independent study (OPNS 499-0 Independent Study), in addition to the 11 required courses listed above.

Other PhD Degree Requirements

- Examinations: Students will take a comprehensive qualifying exam at the end of the first year on the subjects of microeconomics, optimization and stochastic models.
- Research/Projects: Oral presentation of a research paper to a faculty committee that demonstrates competency in operations research during the first week of the fall quarter of the third year.
Upon successfully passing this summer paper and maintaining a 3.0 GPA in the coursework, students are admitted to candidacy.

- **PhD Dissertation**: Original and significant research. Topic and advisor or advisors should be selected in the third year; presentation of preliminary results (prospectus) to the faculty committee no later than December 15 of the fourth year.
- **Final Evaluations**: Oral final examination on dissertation and submission of an approved dissertation.

### Performance Studies

https://communication.northwestern.edu/programs/ma_phd_performance_studies

Degree Types: PhD, MA

The Department of Performance Studies (https://communication.northwestern.edu/programs/ma_phd_performance_studies) is committed to the interdisciplinary study of performance. Students in the program produce provocative research and creative work in cultural studies and ethnography, performance theory and criticism, and the adaptation and staging of narrative texts.

The program works closely with other departments and programs within the University. Coursework and research draws from anthropology, African studies, African-American studies, gender studies, radio-TV-film, theatre & drama, and others.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program please visit the Interdisciplinary Clusters page.

### Degrees Offered

- Performance Studies MA (p. 91)
- Performance Studies PhD (p. 91)

### Performance Studies MA

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

**Total Units Required**: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERF_ST 410-0</td>
<td>Studies in Performance</td>
</tr>
<tr>
<td>PERF_ST 518-0</td>
<td>Seminar: Problems in Research</td>
</tr>
</tbody>
</table>

Electives in consultation with Director of Graduate Studies (5 units)

**Other MA Degree Requirements**

- **Examinations**: comprehensive examination
- **Research/Projects**: 20-30 minute graduate recital developed in PERF_ST 410-0 Studies in Performance
- **Master’s Thesis**: none specified
- **Other**: none

### Performance Studies PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**PhD**

**Total Units Required**: 28

(Nine units credit is given for the master’s degree.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>400- or 500-level courses in history of performance traditions, critical theory, media performance, cultural studies, and/or fieldwork (2 units)</td>
<td></td>
</tr>
<tr>
<td>PERF_ST 410-0</td>
<td>Studies in Performance</td>
</tr>
<tr>
<td>PERF_ST 509-0</td>
<td>Performance &amp; Pedagogy</td>
</tr>
<tr>
<td>PERF_ST 518-0</td>
<td>Seminar: Problems in Research</td>
</tr>
</tbody>
</table>

Electives in consultation with Director of Graduate Studies (23 units)

**Other PhD Degree Requirements**

- **Examinations**: foreign language examination equivalent to two years of college study; qualifying examination taken in spring quarter of final year of coursework
- **Research/Projects**: 20-30 minute graduate recital developed in PERF_ST 410-0 Studies in Performance (if not completed as part of master’s degree)
- **PhD Dissertation**: topic developed in coursework
- **Final Evaluations**: oral defense of dissertation

### Philosophy

https://www.philosophy.northwestern.edu/

Degree Types: PhD

The Doctoral Program in Philosophy (https://www.philosophy.northwestern.edu/graduate) trains students historically and systematically, fosters the growth of philosophical skills, and encourages broad and incisive exploration of individual interests.

The philosophy core curriculum is flexible and allows students to pursue individual research interests. Strengths of the department include ancient philosophy, epistemology and metaphysics, European philosophy, philosophy of mind and language, and ethics and political philosophy.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program please visit the Interdisciplinary Clusters (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates) page.

### Degrees Offered

- Philosophy PhD (p. 91)

### Philosophy PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).
Master's
The Philosophy Department does not have a terminal master's program, but a student may receive the M.A. degree after two years of satisfactory work in the PhD program.

PhD
Total Units Required: 18 (if student holds an M.A. in Philosophy) or 24 (if student does not hold an M.A. in Philosophy)

General Coursework Requirements
During the first and second year, students take a total of 18 courses, 12 of which must be graduate seminars taught in the Northwestern Philosophy department.

During the third year, students take an additional 6 graduate seminars taught in the Northwestern Philosophy department. This requirement is waived if student already has an M.A. degree.

Distribution Requirements
Students must take at least one Philosophy Department course, at the 300- or 400-level, in each of the following areas:
- Ancient Philosophy
- Modern Philosophy
- Contemporary Philosophy Category A: moral or political philosophy
- Contemporary Philosophy Category B: metaphysics, epistemology, philosophy of language, philosophy of mind, or philosophy of science.

Proseminar Requirements
During both their first and second years, students are required to take a Philosophy proseminar that is taught over the course of two quarters, usually in the Fall and Winter. The proseminars are intended to present essential aspects of philosophical inquiry and culminate in the production of professional-quality writing.

- PHIL 401-1 Proseminar (1St-Yr Philosophy Grad Students Only), PHIL 401-2 Proseminar (1St-Yr Grad Students Only) - Taken over two quarters during the first year
- PHIL 402-1 Proseminar II, PHIL 402-2 Proseminar (2nd Yr Grad Students Only) - Taken over two quarters during the second year

Skills Requirement
All students must demonstrate competence in at least one secondary skill or area that pertains to their primary philosophical training. This can be achieved in several ways, including the following:
1. Competency in a second language other than English
2. Completion of a course in advanced logic (above 200-level)
3. A skills requirement involving work in a related discipline (e.g. Linguistics, Cognitive Science, Mathematics, etc.) or a complementary philosophical area.

By the end of the first year, students should declare to the DGS what their proposed competence (or competences) will be, and the DGS will arrange a course of study (or an equivalent) that will demonstrate the needed level of training.

Logic Requirement
Standardly, students attend lectures for PHIL 250-0 Elementary Logic II, and enroll with the instructor of the class in an independent study. Graduate students are expected to undertake additional work so that their coursework is at the 300- or 400-level.

Alternative arrangements may be made to fulfill this requirement with the approval of the logic advisor.

Other PhD Degree Requirements
- Research/Projects: two qualifying papers, one to be completed in each of the first two years.
- Dissertation Research Seminars: one presentation in each of the third and fourth years.
- Dissertation Prospectus and Oral Prospectus Defense
- PhD Dissertation
- Final Evaluations: oral defense of dissertation
- Other: annual review by faculty

Physical Therapy and Engineering
https://www.feinberg.northwestern.edu/sites/pthms/our-programs/dpt-phd.html

Degree Types: DPT/PhD

The combined Doctoral Program in Physical Therapy and Engineering (https://www.feinberg.northwestern.edu/sites/pthms/our-programs/dpt-phd.html) (DPT/PhD(Eng)) gives students a unique opportunity to receive training as both PhD level engineers and licensed physical therapy doctors (DPT). Students meet dual degree requirements in less time than if degrees were pursued separately.

This program focuses on the pathophysiology of movement disorders and how the resulting impairments and handicaps impact the design of therapeutic devices, rehabilitation strategies, and patients' quality of life. Graduates from the DPT/PhD(Eng) program are expected to become new leaders in engineering, rehabilitation sciences, physical therapy and in device development for the study and restoration of human function both in the academic, governmental, healthcare and industry environments.

Students interested in the dual degree program are required to apply to each program separately and acceptance into the program is contingent upon acceptance into both programs.

This program is a coordinated effort between the Departments of Physical Therapy and Human Movement Sciences (https://www.feinberg.northwestern.edu/sites/pthms), Biomedical Engineering (https://www.mccormick.northwestern.edu/biomedical), Mechanical Engineering (https://www.mccormick.northwestern.edu/mechanical), and Electrical and Computer Engineering (https://mccormick.northwestern.edu/electrical-computer).

Degrees Offered
- Physical Therapy and Engineering DPT/PhD (p. 92)

Physical Therapy and Engineering DPT/PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

DPT/PhD(Eng)
Total units required for the PhD component of the combined degree is in accordance with the specific PhD program:
DPT/PhD(Eng) Joint Program Sequence
The curriculum is designed to allow a student to successfully complete the DPT, sit for the PT license exam, gain valuable clinical experience, and complete the PhD degree within a seven year timeframe.

- **First Year:** Core Engineering Coursework (see relevant degree program for specifics); pre-requisite course for DPT; selection of primary research lab
- **Second Year:** Development of dissertation proposal; preparation for qualifying examination and/or proposal defense; advancement to PhD candidacy at the end of the second year (see requirements for specific PhD program)
- **Third Year:** 1st Year DPT Training; execution of preliminary study (typically one of the dissertation aims); 1st clinical experience
- **Fourth Year:** 2nd Year DPT Training; defense of preliminary study; 2nd clinical experience
- **Fifth Year:** Completion of DPT Training; final long-term clinical experiences; PT Licensure; clinical practice placement; continuation of PhD work
- **Sixth-Sventh Years:** Part-time clinical practice; progress towards completion of PhD

Part-time Clinical Practice Requirement
It is critical that students develop expertise within the clinical environment in addition to their academic development so that they have a well-rounded appreciation to clinical problems that require engineering solutions. Upon completion of the DPT program, students will be required to sit for the PT license exam within the state of Illinois. They are required to pass the exam within three attempts. Students will be placed within a supervised clinical practice environment 8-12 hours per week. Students will be paid a supplemental salary by the clinical institution. Potential clinical practice sites are established between Northwestern Medicine, Shirley Ryan AbilityLab, and private practice clinics throughout Chicago and the suburbs.

Other DPT/PhD Degree Requirements
- **Examinations:** Graduate qualifying examinations for admission to candidacy
- **Research/Projects:** Thesis research
- **PhD Dissertation:** Original, independent research presented in a defensible thesis of high quality
- **Final Evaluations:** Defense of dissertation

Physical Therapy and Public Health
https://www.feinberg.northwestern.edu/sites/pthms/

Degree Types: DPT/MPH

The DPT/MPH prepares physical therapists for careers as leaders who will span the boundaries between physical therapy and public health. Students in the Dual DPT/MPH degree program complete coursework and clinical requirements to satisfy the requirements for each degree. DPT courses (https://www.feinberg.northwestern.edu/sites/pthms/our-programs/dpt) are scheduled during the day while MPH courses (https://www.feinberg.northwestern.edu/sites/cehs/our-programs/) program-in-public-health) are offered in the evenings. Students begin MPH coursework the summer before matriculation into the DPT program and then take one or two MPH courses each term along with the regular DPT course load. The required professional experiences for each degree coordinate so that MPH field and culminating experiences coincide and complement DPT clinical education and the synthesis research project. Students will work closely with their faculty advisor to plan a coursework, field experience, and culminating experience to complete both programs in 3 years.

Degrees Offered
- Physical Therapy and Public Health DPT/MPH (p. 93)

Physical Therapy and Public Health DPT/MPH

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Required MPH Courses for DPT/MPH Degree

Total Units Required: 12.5 MPH units

The DPT is an eight-trimester program consisting of 50 courses with a curriculum designed around the premise that the PT must be able to perform in the realm of practitioner, educator, researcher, and consultant. The curriculum includes the basic sciences and courses that cover both clinical concepts and professional issues. There is a strong emphasis on managing the patient as a person instead of a diagnosis and understanding the various environmental factors that contribute to how a person responds to their health status. The clinical education component consists of integrated and terminal experiences. Integrated (part-time) clinical education experiences begin in the 1st trimester and continue throughout the curriculum. Full-time clinical education experience include two, 6-week experiences and two, 13-week experiences. The 1st six-week full-time clinical experience occurs after the completion of the 1st year of didactic course work. The 2nd six-week full-time clinical experience occurs after the winter trimester of the 2nd year of didactic course work. Clinical Experience III and IV occur after completion of all didactic coursework. The DPTHMS Directors of Clinical Education are supportive of dual degree students and will work with students on an individual basis to ensure that DPTHMS clinical education requirements are met while allowing the students to meet MPH requirements.

Other Degree Requirements
The MPH Culminating Experience (MPH-CE) is a capstone-style extensive research or practice-related project in the area of public health completed during students' final year of study. The MPH-CE process provides the structure that allows the student to take responsibility for and to succeed in the development, conduct, and completion of a public health focused research or practice project. The student also gains experience in writing and publicly presenting the MPH-CE project. Students complete a paper similar to what might be submitted to a journal for publication and give a presentation of their Culminating Experience. Students will enroll in PUB_HLTH 560-0 Culminating Experience in the quarter in which they plan to submit the MPH-CE paper and deliver the presentation. Students enrolled in the dual degree program may register for PUB_HLTH 560-0 Culminating Experience and present the MPH-CE earlier in their graduate
careers, but the MPH degree will not be awarded until the DPT is conferred.

Students will also complete an Applied Practical Experience (APEX), a 160-hour practice experience in a public health agency in the Chicago area or elsewhere in the world. It is not a research project although some students collect data or in some other manner participate in a research project as part of their experience. The MPH Professional Experiences Committee (PEC) assists students with APEX placements, and is responsible for reviews of APEX proposals. After completing their applied practical experiences, students make a poster presentation and submit a 5-page paper summarizing their APEX.

Physics

https://www.physics.northwestern.edu/

Degree Types: PhD, MS

Graduate Programs in Physics (https://www.physics.northwestern.edu/graduate) prepare students for careers in research, teaching, or industry. Students first acquire a strong theoretical background in quantum mechanics, statistical physics, electrodynamics, and classical mechanics.

Our department is particularly strong in multi-disciplinary research, with joint faculty in materials science, chemistry, and electrical engineering. Theoretical research in many fields is carried out with the aid of parallel supercomputers on campus and at the National Center for Supercomputing Applications in Champaign, Illinois. We also have strong ties to the Argonne National Laboratory, Fermi National Accelerator Laboratory, and ground-based observational facilities around the nation.

It is not unusual for students to conduct the bulk of their research with physicists outside the department, and in some cases outside the nation.

Degrees Offered

- Physics MS (p. 94)
- Physics PhD (p. 95)

Physics MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

Physics is a broad subject, ranging from pondering the origins of the universe to designing better electronic memory devices.

Young students and junior researchers from around the world are welcome to obtain a solid basis in the fundamentals of physics and to pursue their particular interests and professional goals at Northwestern.

The master’s program in Physics is designed to meet the needs of individuals who have the interest and skills needed to learn physics but who will not spend several years in graduate school earning a doctorate. Students are meant to complete the requirements within four quarters, starting with basic "core" courses in classical mechanics, electrodynamics, quantum mechanics and statistical physics, followed by a number of elective courses drawn from many departments at Northwestern.

The keyword for the program is flexibility - students should be empowered to study what is most relevant to their goals.

For inquiries, please contact the Director of the master’s program, Andrew Geraci (andrew.geraci@northwestern.edu).

Within the master’s program, there are two paths to completion, called “Standard” and “Broad.” They share the same core requirement.

Standard Path:

- Five core courses (see below)
- Four elective courses (see below)
- Master’s Thesis
  - Either an in-depth reading project, or a research project, supervised by an appropriate faculty member, similar to PHYSICS 499-0 Independent Study
  - Thesis to be presented for evaluation.
  - Should be completed by end of summer quarter.

Broad Path:

- Five core courses (see below)
- Seven elective courses (see below)

The Standard Path to the master’s degree should be completed within one calendar year; the nine courses would be taken during the winter, fall and spring quarters and the master’s thesis would be written during the summer. The Broad Path would be completed typically in 15 months; nine courses would be taken during the winter, fall and spring quarters, and the additional three courses would be taken in the fall quarter of the second year.

Core Courses: To be completed in fall & winter quarters

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 411-0</td>
<td>Classical Mechanics (fall)</td>
</tr>
<tr>
<td>PHYSICS 412-1</td>
<td>Quantum Mech (fall)</td>
</tr>
<tr>
<td>PHYSICS 412-2</td>
<td>Quantum Mechanics (winter)</td>
</tr>
<tr>
<td>PHYSICS 414-1</td>
<td>Electrodynamics (winter)</td>
</tr>
<tr>
<td>PHYSICS 416-0</td>
<td>Introduction to Statistical Mechanics (winter)</td>
</tr>
</tbody>
</table>

Elective Courses: At least four from this list, during spring and fall quarters.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 411-1</td>
<td>Methods of Theoretical Physics</td>
</tr>
<tr>
<td>PHYSICS 412-2</td>
<td>Quantum Mechanics</td>
</tr>
<tr>
<td>PHYSICS 412-3</td>
<td>Quantum Mechanics</td>
</tr>
<tr>
<td>PHYSICS 414-2</td>
<td>Electrodynamics</td>
</tr>
<tr>
<td>PHYSICS 420-0</td>
<td>Statistical Physics</td>
</tr>
<tr>
<td>PHYSICS 422-1</td>
<td>Condensed-Matter Physics</td>
</tr>
<tr>
<td>&amp; PHYSICS 422-2</td>
<td>and Condensed-Matter Physics</td>
</tr>
<tr>
<td>&amp; PHYSICS 422-3</td>
<td>and Condensed-Matter Physics</td>
</tr>
<tr>
<td>PHYSICS 424-1</td>
<td>Particle Physics</td>
</tr>
<tr>
<td>&amp; PHYSICS 424-2</td>
<td>and Particle Physics</td>
</tr>
<tr>
<td>PHYSICS 426-0</td>
<td>Nonlinear Optics</td>
</tr>
<tr>
<td>PHYSICS 430-0</td>
<td>Nonlinear Dynamics &amp; Chaos</td>
</tr>
<tr>
<td>PHYSICS 432-1</td>
<td>Many-Body Theory</td>
</tr>
<tr>
<td>&amp; PHYSICS 432-2</td>
<td>and Many-Body Theory</td>
</tr>
</tbody>
</table>
Physics PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**MS Degree Requirements for PhD Students**

Students enrolled in the Ph.D. program have the opportunity to obtain a formal master’s degree as they work toward completion of the Ph.D. These requirements are as follows:

1. Completion of seven core courses in the first year
2. Completion of five or more elective courses in the second year
3. GPA of 3.0 or higher

**PhD**

Total Units Required: 13

(All but electives are required for the MS degree.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 434-0</td>
<td>Quantum Fluids, Solids, and Gases</td>
</tr>
<tr>
<td>PHYSICS 435-0</td>
<td>Soft Matter Physics</td>
</tr>
<tr>
<td>PHYSICS 436-0</td>
<td>Mesoscopic and Nanometer Scale Physics</td>
</tr>
<tr>
<td>PHYSICS 445-1 &amp; PHYSICS 445-2</td>
<td>General Relativity and General Relativity</td>
</tr>
<tr>
<td>ASTRON 421-0</td>
<td>Observational Astrophysics</td>
</tr>
<tr>
<td>ASTRON 425-0</td>
<td>Stellar Astrophysics</td>
</tr>
<tr>
<td>ASTRON 429-0</td>
<td>Extragalactic Astrophysics and Cosmology</td>
</tr>
<tr>
<td>ASTRON 443-0</td>
<td>Stellar Structure and Evolution</td>
</tr>
<tr>
<td>ASTRON 448-0</td>
<td>Interstellar Matter and Star Formation</td>
</tr>
<tr>
<td>ASTRON 449-0</td>
<td>Stellar Dynamics</td>
</tr>
</tbody>
</table>

**PHYSICS 440-0** | Advanced Topics in Nuclear Physics
**PHYSICS 441-0** | Statistical Methods for Physicists and Astronomers
**PHYSICS 442-0** | Advanced Topics in Particle Physics
**PHYSICS 445-0** | Advanced Topics in Condensed Matter
**PHYSICS 446-0** | Advanced Topics in Statistical Physics
**PHYSICS 447-0** | Introduction to Biological Physics: From Molecules to Cells (IBiS 410)
**PHYSICS 448-0** | Advanced Topics in Atomic, Molecular, and Optical Physics

**Other PhD Degree Requirements**

- **Examinations:** There is no longer a written qualifying exam. Should a student’s grades in the core courses fall below a 3.0, the student will be required to sit for an oral qualifier with a chosen committee.
- **Research/Projects:** original research project of publishable quality
- **PhD Dissertation:** none specified beyond the PhD degree requirements outlined in the Current Students section of this Web site
- **Final Evaluations:** none specified beyond the PhD degree requirements outlined in the Current Students section of this Web site

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**Plant Biology and Conservation**

https://www.plantbiology.northwestern.edu/

Degree Types: MS, PhD

The Program in Plant Biology and Conservation focuses on preparing students for future leadership positions in botanical science and plant conservation. In response to growing national and international threats to biodiversity and impending global mass extinctions, the program is designed to train future botanists who have the skills to meet and address this crisis.

Conducted jointly by Northwestern University (NU) and the Chicago Botanic Garden (CBG), the program offers a master of science and doctoral degree through The Graduate School at Northwestern University. Advanced courses are taught by NU professors and CBG scientists in a variety of fields, including conservation biology, genetics, plant and soil ecology, evolution, plant science, environmental science and policy, geology, environmental economics, and anthropology. Many courses offered by CBG are taught at the Garden.

**Degrees Offered**

- Plant Biology and Conservation MS (p. 95)
- Plant Biology and Conservation PhD (p. 96)

---

**Plant Biology and Conservation MS**

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master’s**

Overview of MS Tracks in Plant Biology and Conservation

**Thesis MS**

Total Units Required: 11
### Plant Biology and Conservation PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

## PhD

**Total Units Required: 13**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses (4 units)</td>
<td></td>
</tr>
<tr>
<td>PBC 450-0</td>
<td>Field and Laboratory Methods in Plant Biology and Conservation (2 units)</td>
</tr>
<tr>
<td>PBC 451-0</td>
<td>Critical Topics in Ecology and Conservation (1 unit)</td>
</tr>
<tr>
<td>PBC 435-0</td>
<td>Quantitative Methods for Ecology &amp; Conservation (1 unit)</td>
</tr>
<tr>
<td>Electives (5 units)</td>
<td></td>
</tr>
<tr>
<td>One elective from Ecology and Evolution/Genetics is recommended:</td>
<td></td>
</tr>
<tr>
<td><strong>Ecology</strong></td>
<td></td>
</tr>
<tr>
<td>PBC 402-0</td>
<td>Plant Community Ecology (1 unit)</td>
</tr>
<tr>
<td>PBC 418-0</td>
<td>Soils and the Environment: The Earth’s Critical Zone (1 unit)</td>
</tr>
<tr>
<td><strong>Evolution/Genetics</strong></td>
<td></td>
</tr>
<tr>
<td>PBC 401-0</td>
<td>Plant Evolution &amp; Diversity Lab (1 unit)</td>
</tr>
<tr>
<td>PBC 430-0</td>
<td>Conservation Genetics (1 unit)</td>
</tr>
<tr>
<td>BIOL_SCI 341-0</td>
<td>Population Genetics (1 unit)</td>
</tr>
<tr>
<td>BIOL_SCI 378-0</td>
<td>Functional Genomics (1 unit)</td>
</tr>
<tr>
<td>Independent Study (PBC 499-0)</td>
<td>(2 units)</td>
</tr>
</tbody>
</table>

**Capstone**

Research/Thesis

**Land Management non-thesis MS**

**Total Units Required: 9**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td></td>
</tr>
<tr>
<td>PBC 450-0</td>
<td>Field and Laboratory Methods in Plant Biology and Conservation (2 units)</td>
</tr>
<tr>
<td>PBC 451-0</td>
<td>Critical Topics in Ecology and Conservation (1 unit)</td>
</tr>
<tr>
<td>PBC 435-0</td>
<td>Quantitative Methods for Ecology &amp; Conservation (1 unit)</td>
</tr>
<tr>
<td>PBC 402-0</td>
<td>Plant Community Ecology (1 unit)</td>
</tr>
<tr>
<td>Total core: 5 units</td>
<td></td>
</tr>
<tr>
<td>Electives</td>
<td>Total electives: 4 units</td>
</tr>
</tbody>
</table>

**Capstone**

Internship/Project

**Duration**

1 year

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### Political Science

**https://www.polisci.northwestern.edu/**

**Degree Types: PhD**

The Political Science PhD Program (https://www.polisci.northwestern.edu/graduate) is designed for students whose primary concern is a mastery of theories, methods of research, and substantive literature of the discipline of political science.

The program reflects an effort to address big questions in politics by combining multiple social science methodologies including quantitative, qualitative, experimental, interpretive methods. Committed to excellence in research and teaching, methodological diversity, and interdisciplinary collaborations, the department offers a stimulating intellectual community that is committed to diversity and equality of opportunity for students and faculty of all backgrounds.

We offer field training in American politics, comparative politics, political theory, international relations, and methods. Our graduate training strengths include:

- Race, Ethnicity and Politics (https://www.polisci.northwestern.edu/research/subfield-specialties/race.html)
- Conflict Studies (https://www.polisci.northwestern.edu/research/subfield-specialties/conflict-studies.html)
- American Political Development (https://www.polisci.northwestern.edu/research/subfield-specialties/american-political-development.html)
- International Theory (https://www.polisci.northwestern.edu/research/subfield-specialties/international-theory.html)
- Comparative Historical Analysis (https://www.polisci.northwestern.edu/research/subfield-specialties/comparative-historical-studies.html)
- Feminist and Gender Studies (https://www.polisci.northwestern.edu/research/subfield-specialties/gender-politics.html)

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program please visit the Interdisciplinary Clusters page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).
Degrees Offered

- Political Science PhD (p. 97)

Political Science PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required courses</td>
<td></td>
</tr>
<tr>
<td>POLI_SCI 403-0</td>
<td>Introduction to Probability and Statistics ¹</td>
</tr>
<tr>
<td>POLI_SCI 405-0</td>
<td>Linear Models</td>
</tr>
<tr>
<td>Other courses approved by the Director of Graduate Studies: 16 units</td>
<td></td>
</tr>
</tbody>
</table>

¹ Political Theory students are occasionally exempt from the requirement to take POLI_SCI 403-0 Introduction to Probability and Statistics and POLI_SCI 405-0 Linear Models.

Other PhD Degree Requirements

- Research Paper Requirement: Scholarly paper in first or second year
- Second Field Requirement (https://www.polisci.northwestern.edu/graduate/program-areas): Five courses in a student's second field, or optional qualifying examination
- Examination: One written qualifying examination in student's first field; optional examination in student's second field
- Prospectus: Dissertation research design presented during the quarter after passing the qualifying examination
- Final Evaluations: Oral defense of dissertation
- Other: Teaching requirement begins in second year in an undergraduate course

Psychology

https://www.psychology.northwestern.edu/graduate/

Degree Types: PhD

The Doctoral Program in Psychology (https://www.psychology.northwestern.edu/graduate) prepares students to be future leaders in scientific psychology through programs in five areas: clinical psychology; personality, development & health psychology; cognitive psychology; social psychology; and brain, behavior, & cognition.

Program faculty and graduate students conduct some of the most exciting and influential research being done in the psychological sciences today. Graduate students in our program receive rigorous training in methodology, statistics, and broad content areas in psychology.

Students take both general courses and those specific to their areas of interest. Students also engage in a series of research projects and assist with undergraduate teaching. Collaboration with faculty members within and outside the student's area is very common. Many graduates seek academic careers.

Degrees Offered

- Psychology PhD (p. 97)

Psychology PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

The department offers no terminal master's degree, but students must earn a master's degree as one of the requirements for the PhD degree. To obtain the MA or MS degree, students take the courses required for the specialized field and complete a master's thesis.

PhD

Total Units Required: 27

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td></td>
</tr>
<tr>
<td>PSYCH 401-1</td>
<td>Proseminar--Biological &amp; Cognitive Bases of Behavior</td>
</tr>
<tr>
<td>PSYCH 401-2</td>
<td>Proseminar--Social and Personality Bases of Behavior</td>
</tr>
<tr>
<td>Additional Courses</td>
<td></td>
</tr>
</tbody>
</table>

Additional course requirements differ for the five program areas. ¹

¹ See Department Guide (https://www.psychology.northwestern.edu/graduate/current/graduate-student-handbook.html) for more Information

Other PhD Requirements

- Examinations: For admission to candidacy, written examination or paper.
- Research/Projects: In addition to master's project and PhD dissertation, students expected to engage in supervised research projects
- PhD Dissertation: Result of independent research in specialized field
- Final Evaluations: Oral examination on dissertation
- Other: Teaching assignment (see department guide (https://www.psychology.northwestern.edu/graduate/current/graduate-student-handbook.html))

Public Health


Degree Types: MPH


The program provides students with:

1. a broad perspective on the definition of health highlighting the concepts of prevention, health promotion, health care organization and delivery, and population-based research and intervention and
2. an interdisciplinary public health knowledge base derived from biomedical and social scientific theories and empiric evidence.
Coursework and faculty are drawn from many departments in the Feinberg School of Medicine, including the Institute for Public Health and Medicine, and Global Health Studies in the Weinberg College of Arts & Sciences. The program also includes applied practical experience in a governmental or non-governmental public health setting.

**Degrees Offered**
- Medicine and Public Health MD/MPH (p. 87)
- Physical Therapy and Public Health DPT/MPH (p. 93)
- Public Health MPH (p. 98)

**Public Health MPH**

**Degree Requirements**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

**Master of Public Health**

**Generalist Track**

Total Units Required: 16

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>EPL_BIO 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>or PUB_HLTH 302-0</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>PUB_HLTH 303-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>EPL_BIO 301-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>or PUB_HLTH 304-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 310-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 311-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 312-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 410-0</td>
<td>Field Experience in Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>PUB_HLTH 560-0</td>
<td>Culminating Experience</td>
</tr>
</tbody>
</table>

**Intermediate Level Course Requirement**

| PUB_HLTH 421-0   | Intermediate Biostatistics                              |
| or PUB_HLTH 422-0 | Intermediate Epidemiology                              |

**Methodology Requirement**

One of the following courses in addition to one of the intermediate level courses listed above:

| PUB_HLTH 410-0 | Field Experience in Public Health                      |
| PUB_HLTH 420-0 | Introduction to US Health Care System                  |
| PUB_HLTH 560-0 | Culminating Experience                                  |

**Community Health Selective**

One of the following:

| PUB_HLTH 330-0 | Global Tobacco: Control and Prevention                 |
| PUB_HLTH 414-0 | Injury and Violence Prevention                         |
| PUB_HLTH 415-0 | Disease Prevention and Health Promotion: Principles and Application |
| PUB_HLTH 417-0 | Public Health Law: Promoting Healthy Youth Development |
| PUB_HLTH 448-0 | Introduction to Maternal Child Health                 |

**Electives**

2 units

**Master of Public Health**

**Community Health Research Concentration**

Total Units Required: 16

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Behavior, Society &amp; Health</td>
</tr>
<tr>
<td>PUB_HLTH 310-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>EPL_BIO 301-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>or PUB_HLTH 304-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 310-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 311-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 312-0</td>
<td>Foundations of Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 317-0</td>
<td>Seminar in Community Health Research</td>
</tr>
<tr>
<td>PUB_HLTH 318-0</td>
<td>Seminar in Community Health Research II</td>
</tr>
<tr>
<td>PUB_HLTH 319-0</td>
<td>Seminar in Community Health Research III</td>
</tr>
<tr>
<td>PUB_HLTH 320-0</td>
<td>Community Engaged Research</td>
</tr>
<tr>
<td>PUB_HLTH 323-0</td>
<td>Health Equity</td>
</tr>
<tr>
<td>PUB_HLTH 411-0</td>
<td>Assessment, Planning &amp; Evaluation in Community Health</td>
</tr>
<tr>
<td>PUB_HLTH 410-0</td>
<td>Field Experience in Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 420-0</td>
<td>Introduction to US Health Care System</td>
</tr>
<tr>
<td>PUB_HLTH 560-0</td>
<td>Culminating Experience</td>
</tr>
</tbody>
</table>

**Intermediate Level Course Requirement**

| PUB_HLTH 421-0   | Intermediate Biostatistics                              |
| or PUB_HLTH 422-0 | Intermediate Epidemiology                              |

**Methodology Requirement**

One of the following courses in addition to one of the intermediate level courses listed above:

| PUB_HLTH 416-0 | Program Evaluation                                     |
| PUB_HLTH 421-0 | Intermediate Biostatistics                            |
| PUB_HLTH 422-0 | Intermediate Epidemiology                             |
| PUB_HLTH 425-0 | Introduction to GIS and Spatial Analysis for Public Health |
| PUB_HLTH 438-0 | Survey Design & Methodology                           |
| PUB_HLTH 439-0 | Qualitative Research Methods                          |

**Electives**

2 units

**Master of Public Health**

**Epidemiology Concentration**

Total Units Required: 16

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUB_BIO 301-0</td>
<td>Behavioral &amp; Health</td>
</tr>
<tr>
<td>PUB_BIO 401-0</td>
<td>Epidemiology</td>
</tr>
<tr>
<td>or PUB_BIO 402-0</td>
<td>Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 301-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>EPL_BIO 301-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>or PUB_HLTH 304-0</td>
<td>Introduction to Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 303-0</td>
<td>Environmental Health Sciences</td>
</tr>
<tr>
<td>PUB_HLTH 421-0</td>
<td>Intermediate Biostatistics</td>
</tr>
<tr>
<td>or PUB_HLTH 422-0</td>
<td>Intermediate Epidemiology</td>
</tr>
<tr>
<td>PUB_HLTH 425-0</td>
<td>Introduction to GIS and Spatial Analysis for Public Health</td>
</tr>
<tr>
<td>PUB_HLTH 438-0</td>
<td>Survey Design &amp; Methodology</td>
</tr>
<tr>
<td>PUB_HLTH 439-0</td>
<td>Qualitative Research Methods</td>
</tr>
<tr>
<td>PUB_HLTH 446-0</td>
<td>Design, Conduct &amp; Analysis of Clinical Trials</td>
</tr>
<tr>
<td>ANTHRO 362-0</td>
<td>Advanced Methods in Quantitative Analysis</td>
</tr>
</tbody>
</table>
EPI_BIO 501-0  Advanced Epidemiology
PUB_HLTH 301-0  Behavior, Society & Health
PUB_HLTH 302-0  Introduction to Biostatistics
  or EPI_BIO 302-0  Introduction to Biostatistics
PUB_HLTH 303-0  Environmental Health Sciences
PUB_HLTH 305-0  Programming for Statistical Analysis
PUB_HLTH 310-0  Foundations of Public Health
PUB_HLTH 311-0  Foundations of Public Health
PUB_HLTH 410-0  Field Experience in Public Health
PUB_HLTH 420-0  Introduction to US Health Care System
PUB_HLTH 421-0  Intermediate Biostatistics
PUB_HLTH 560-0  Culminating Experience

Methodology Requirement
One of the following courses:
  PUB_HLTH 425-0  Introduction to GIS and Spatial Analysis for Public Health
  PUB_HLTH 438-0  Survey Design & Methodology
  PUB_HLTH 439-0  Qualitative Research Methods
  PUB_HLTH 446-0  Design, Conduct & Analysis of Clinical Trials

Epidemiology Selective
Select two of the following:
  PUB_HLTH 412-0  Infection Disease Epidemiology and Prevention
  PUB_HLTH 315-0  Topics in Public Health (Cancer Epidemiology)
  PUB_HLTH 524-0  Cardiovascular Disease Epidemiology

Electives
1 unit

Master of Public Health
Global Health Concentration
Total Units Required: 16

Course  Title
Core and Required Courses
PUB_HLTH 301-0  Behavior, Society & Health
PUB_HLTH 302-0  Introduction to Biostatistics
  or EPI_BIO 302-0  Introduction to Biostatistics
PUB_HLTH 303-0  Environmental Health Sciences
EPI_BIO 301-0  Introduction to Epidemiology
  or PUB_HLTH 304-0  Introduction to Epidemiology
PUB_HLTH 310-0  Foundations of Public Health
PUB_HLTH 311-0  Foundations of Public Health
PUB_HLTH 312-0  Foundations of Public Health
PUB_HLTH 410-0  Field Experience in Public Health
PUB_HLTH 420-0  Introduction to US Health Care System
PUB_HLTH 560-0  Culminating Experience

Methodology Requirement
PUB_HLTH 421-0  Intermediate Biostatistics
  or PUB_HLTH 422-0  Intermediate Epidemiology
Select one:
  PUB_HLTH 416-0  Program Evaluation
  PUB_HLTH 425-0  Introduction to GIS and Spatial Analysis for Public Health
  PUB_HLTH 438-0  Survey Design & Methodology
  PUB_HLTH 439-0  Qualitative Research Methods

Required Concentration Courses
PUB_HLTH 390-0  International Public Health I
students for this leadership role. Policy debates and international scholarship at the highest level, and in Religion. Our nationally recognized faculty takes leadership in national and a careful training in academic teaching, a focus of the program. The program is intended to give both a scholarly training in the discipline influenced by other disciplines in the humanities and social sciences. Flexibility allows for rigorous projects grounded in Religious Studies but many students take one qualifying examination in another discipline. This choose at least one dissertation adviser from another department, and students take courses both within and outside the department, most

The program is highly flexible and profoundly interdisciplinary. All students take courses both within and outside the department, most choose at least one dissertation adviser from another department, and many students take one qualifying examination in another discipline. This flexibility allows for rigorous projects grounded in Religious Studies but influenced by other disciplines in the humanities and social sciences. The program is intended to give both a scholarly training in the discipline and a careful training in academic teaching, a focus of the program. Northwestern University is one of America's premier academic programs in Religion. Our nationally recognized faculty takes leadership in national policy debates and international scholarship at the highest level, and trains our students for this leadership role.

Students in this program are also encouraged to participate in TGS's Interdisciplinary Cluster Initiative (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates) and in the Searle Center for Advancing Learning and Teaching (https://www.northwestern.edu/searle). The Clusters offer a strong set of colleagues in areas of specific interest and many students get certificates within the cluster. For more information on finding a second intellectual "home" outside the Department, please visit the Interdisciplinary Clusters page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates). Additional funding is sometimes available through clusters, in addition to our robust support package, the most substantial of any graduate program in the country. Each student is assigned to a leading expert in their field, and works closely with this faculty member throughout their Ph.D program.

For more information on applying to the Department of Religious Studies, please see the Religious Studies Applications page (https://www.religious-studies.northwestern.edu/graduate/admissions/applications.html).

### Degrees Offered

- Religious Studies PhD (p. 100)

### Religious Studies PhD

#### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

#### Master’s

The Department of Religion does not admit students to a terminal master of arts program. However, PhD students in good standing are awarded the MA after they have met the following criteria:

- 5 quarters of residency
- successful completion of the two-quarter Religion research paper (RELIGION 570-1 Research Seminar, RELIGION 570-2 Research Seminar)
- 11 other courses graded ABC/NC

Note: Students whose second department’s curriculum makes RELIGION 570-1 Research Seminar, RELIGION 570-2 Research Seminar impossible may petition for an oral examination in lieu of paper but must have a total of 13 ABC/NC courses.

#### PhD

**Total Units Required: 16**

* including introductory graduate sequence during the first year

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELIGION 481-1 &amp; RELIGION 481-2</td>
<td>Classical Theories of Religion and Contemporary Theories of Religion</td>
</tr>
<tr>
<td>RELIGION 482-0 &amp; RELIGION 570-1 &amp; RELIGION 570-2</td>
<td>Themes in Comparative Religion and Research Seminar</td>
</tr>
</tbody>
</table>

**Additional Courses**

11 additional courses in Religion and/or affiliated disciplines
Reproductive Science and Medicine

https://www.crs.northwestern.edu/education/reproductive-science-training/ms-rsm/index.html

Degree Types: MS

The master of science in reproductive science and medicine (MS-RSM) is a full-time, terminal master of science degree focusing on human reproductive biology and medicine. We offer thesis and non-thesis tracks to meet the needs of our applicants and their professional goals. Students will also be part of a vibrant community of reproductive scientists through the Center for Reproductive Science (https://www.crs.northwestern.edu).

A majority of program courses and activities are located on the Northwestern University Chicago campus in Illinois, USA. However, the program is cross-campus and some core courses, electives, and thesis research opportunities are located on the Northwestern University Evanston campus and the Stanley Manne Children’s Research Institute, also in Illinois, USA. University shuttles connect the campuses and are free to students.

Program graduates will be prepared for research and technical positions with academic, clinical, and pharmaceutical laboratories. Students will also have a foundation for further training to PhD and medical degree programs.

Degrees Offered

- Reproductive Science and Medicine MS (p. 101)

Reproductive Science and Medicine MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Thesis Track

Total Units Required: 11-15

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPR_SCI 405-0</td>
<td>Female Reproductive Physiology and Endocrinology</td>
</tr>
<tr>
<td>REPR_SCI 406-0</td>
<td>Emerging Research in Reproductive Science and Medicine</td>
</tr>
<tr>
<td>REPR_SCI 407-0</td>
<td>Male Reproductive Physiology and Endocrinology</td>
</tr>
<tr>
<td>REPR_SCI 420-0</td>
<td>Human Reproductive Health and Disease</td>
</tr>
<tr>
<td>REPR_SCI 425-0</td>
<td>Responsible Conduct of Research in Reproductive Science</td>
</tr>
<tr>
<td>REPR_SCI 455-0</td>
<td>Research Proposals</td>
</tr>
<tr>
<td>REPR_SCI 497-0</td>
<td>Assessment and Career Planning</td>
</tr>
</tbody>
</table>

Required Research Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGS 512-0</td>
<td>Continuous Registration (Summer Research, optional)</td>
</tr>
</tbody>
</table>

Non-Thesis Track

Total Units Required: 11-15

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPR_SCI 440-0</td>
<td>Reproductive Technologies Laboratory</td>
</tr>
<tr>
<td>REPR_SCI 591-0</td>
<td>Thesis Research in Reproductive Science and Medicine</td>
</tr>
<tr>
<td>REPR_SCI 595-0</td>
<td>Research in Reproductive Science and Medicine</td>
</tr>
</tbody>
</table>

Other MS Degree Requirements-Thesis Track

- Examinations: A written thesis and public presentation are in lieu of a final examination.
- Research/Projects: Students are required to join a thesis lab during winter quarter of their first year.
- Master’s Thesis: The MS-RSM thesis track requires a written thesis submitted during the student’s final quarter in the program.

Other MS Degree Requirement-Non-Thesis Track

- Examinations: Students complete a written final examination to earn the MS degree.
- Research/Projects: Students are not required to perform research for the degree. Students have the option to complete research during the summer quarter after required courses and the final examination are complete.
- Master’s Thesis: The non-thesis track does not require a master’s thesis.

Electives (Optional)

Students may choose from a variety of electives to complete their degree. Electives enable students to tailor their degree to professional and personal interests by developing a focus area and/or achieve breadth. Electives span several topics. General areas of interest are listed below. Students may take any TGS course and are not limited to the list when determining electives.

- Anthropology (https://www.anthropology.northwestern.edu/graduate/courses)
- Medical Humanities and Bioethics (https://www.bioethics.northwestern.edu/education/ma-students/current-students/course-schedule.html)
• Clinical Investigation (https://www.nucats.northwestern.edu/education-and-career-development/investigator-development/curriculum)
• Healthcare Quality and Patient Safety (https://www.feinberg.northwestern.edu/sites/cehs/our-programs/phd-program/about/healthcare-quality-and-patient-safety)
• Biostatistics and Epidemiology (https://www.mccormick.northwestern.edu/academics/programs/epidemiology-and-biostatistics/requirements.html)
• Gender Studies (https://www.gendersexuality.northwestern.edu/graduate/certificate-cluster-requirements.html)
• Life Sciences (https://www.feinberg.northwestern.edu/sites/dgp/prospective-students/courses.html)
• Interdisciplinary Biological Sciences (https://www.ibis.northwestern.edu/graduate/current)
• Biomedical Engineering (https://www.mccormick.northwestern.edu/biomedical/courses)
• Biotechnology (https://www.mccormick.northwestern.edu/biotechnology/curriculum/course-schedules.html)

Screen Cultures

https://communication.northwestern.edu/programs/phd_screencultures/

Degree Types: PhD

The Screen Cultures PhD Program (https://communication.northwestern.edu/programs/phd_screencultures) continues Northwestern’s historical leadership in the cultural and critical analysis of film, television, and emerging media by integrating interdisciplinary opportunities both within the School of Communication and across the University. A humanities-based program grounded in critical and cultural theory, cultural history, and media poetics, Screen Cultures conducts and mentors research in the history and critical analysis of media texts, technologies, and cultures.

The program is designed to provide in-depth knowledge of the field of film and media while allowing students to develop and design interdisciplinary research by taking coursework and attending events in other programs across the humanities and social sciences.

Students work with faculty across campus and with internationally known scholars in film and media studies. In addition to core subjects, students can also enroll in media production courses and specialty seminars with topics such as: media and architecture, gender and media, African American cinema, cult cinema, television and media arts, transnational cinema, Middle Eastern cinema, and numerous author and genre courses.

The program is enhanced by our Center for Screen Cultures and quarterly colloquia, which hosts visiting lecturers and campus-wide events.

Degrees Offered

• Screen Cultures PhD (p. 102)

Screen Cultures PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

Total Units Required: 18 or 27

There are 10 classes that comprise the core in Screen Cultures. In addition, students take a combination of electives and independent studies as described below. Students who start with an MA have six quarters of full-time work before taking their exams; students who start with a BA have 9 quarters of full-time enrollment prior to exams.

Students take ten required Screen Cultures classes as part of their overall course work. Beyond that, students take graduate-level electives in Screen Cultures and in other departments. Students who start the program with a bachelors degree may take up to three (3) 300-level courses in the department. Students register for research during the summer as long as they are funded, and pursue research and directed reading under the supervision of their faculty advisor.

Required Core Courses (4 units)

At least four of the following courses are required, which can be taken anytime during coursework.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTVF 402-0</td>
<td>Television and Media Theory</td>
</tr>
<tr>
<td>RTVF 403-0</td>
<td>Media and Cultural Theory</td>
</tr>
<tr>
<td>RTVF 410-0</td>
<td>Media Historiography</td>
</tr>
<tr>
<td>RTVF 420-0</td>
<td>Film Theory &amp; Criticism</td>
</tr>
<tr>
<td>RTVF 422-0</td>
<td>Textual Analysis</td>
</tr>
<tr>
<td>RTVF 426-0</td>
<td>Global Media</td>
</tr>
</tbody>
</table>

Required Cultural History Courses (2 units)

In addition, two of the following cultural history courses are required.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTVF 411-0</td>
<td>Cultural History of Television</td>
</tr>
<tr>
<td>RTVF 412-0</td>
<td>Cultural History of Film</td>
</tr>
<tr>
<td>RTVF 413-0</td>
<td>Cultural History of New Media</td>
</tr>
</tbody>
</table>

Additional Required Courses in Screen Cultures (4 units)

• RTVF 502-0 Writing Practicum is required for all Screen Cultures graduate students to be taken in the spring quarter before they take their PhD Exam and defend their prospectus.

• Three additional Screen Cultures seminars at the 400 or 500 levels are required.

Electives

In addition to the required core courses, students take graduate-level electives in Screen Cultures, in other departments and programs at Northwestern, and courses offered through the Big Ten Traveling Scholar Program or the Chicago Metropolitan Exchange Program.

• Students arriving at Northwestern with a MA must complete 8 elective courses.

• Students arriving at Northwestern with a BA must complete 17 elective courses.
Independent Studies: Students typically take 2-3 independent studies as part of their graduate work.

Slavic Languages and Literatures
https://www.slavic.northwestern.edu/

Degree Types: PhD

Northwestern’s Doctoral Program in Slavic Languages and Literatures (https://www.slavic.northwestern.edu/graduate), one of the best in the country, specializes in Russian literature and culture. It focuses on the readings of major works, their relation to cultural and intellectual history, and the questions they raise for problems of literary criticism and theory.

The program allows reasonable flexibility in designing a course of study, giving students the ability to follow their research interests. As a result, students acquire the skills necessary for creative thinking, original research, and professional exposition. The program also provides training in language teaching methodology.

Students in this program are also encouraged to participate in TGS’s Interdisciplinary Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program, please visit the Interdisciplinary Clusters page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).

Degrees Offered
- Slavic Languages and Literatures PhD (p. 103)

Slavic Languages and Literatures PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s

The Slavic Languages and Literatures Department does not offer a terminal MA degree. The MA degree is awarded to students in the PhD program who meet the MA requirements.

Total Units Required: 9

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td></td>
</tr>
<tr>
<td>SLAVIC 360-0</td>
<td>Survey of 19th Century Russian Poetry</td>
</tr>
<tr>
<td>SLAVIC 361-0</td>
<td>Survey of 20th Century Russian Poetry</td>
</tr>
<tr>
<td>SLAVIC 411-0</td>
<td>Proseminar</td>
</tr>
<tr>
<td>SLAVIC 430-0</td>
<td>Studies in Old Russian Literature</td>
</tr>
<tr>
<td>SLAVIC 434-0</td>
<td>Studies in 18th Century Russian Lit</td>
</tr>
<tr>
<td>SLAVIC 436-0</td>
<td>Studies in 19th Century Russian Lit</td>
</tr>
<tr>
<td>SLAVIC 438-0</td>
<td>Studies in 20th Century Russian Literature (1900-1930s)</td>
</tr>
</tbody>
</table>

Other department courses or approved related courses: 5-6

Other MA Degree Requirements
- Examinations: article-length written work and oral presentation
- Research/Projects: none specified
- Master’s Thesis: none specified
- Other: none

PhD

Total Units Required: 18

Coursework Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Courses</td>
<td></td>
</tr>
<tr>
<td>SLAVIC 360-0</td>
<td>Survey of 19th Century Russian Poetry</td>
</tr>
<tr>
<td>SLAVIC 361-0</td>
<td>Survey of 20th Century Russian Poetry</td>
</tr>
<tr>
<td>SLAVIC 411-0</td>
<td>Proseminar</td>
</tr>
<tr>
<td>SLAVIC 430-0</td>
<td>Studies in Old Russian Literature</td>
</tr>
<tr>
<td>SLAVIC 434-0</td>
<td>Studies in 18th Century Russian Lit</td>
</tr>
<tr>
<td>SLAVIC 436-0</td>
<td>Studies in 19th Century Russian Lit</td>
</tr>
<tr>
<td>SLAVIC 438-0</td>
<td>Studies in 20th Century Russian Literature (1900-1930s)</td>
</tr>
<tr>
<td>Other department courses: 6</td>
<td></td>
</tr>
<tr>
<td>Seminars (300- and 400-level): 6</td>
<td></td>
</tr>
</tbody>
</table>

Other PhD Degree Requirements
- Examinations: comprehensive written examinations generally given in winter quarter of third year; exams cover all periods and genres of Russian literature and Russian intellectual history; students with master's degree from another institution or with exceptionally strong background may take exams in second year; after successful completion of written exams, students take two-hour oral exam
- Research/Projects: in second year, students choose professor with whom to rework paper written for a previous seminar; paper is reworked into publishable article and presented orally to students and faculty in spring of second year
- PhD Dissertation: fourth-year students must present preview of dissertation orally to students and faculty of department; dissertation proposal due beginning of fourth year
- Final Evaluations: approval of dissertation
- Languages: Each first-year student must take a diagnostic Russian language placement test, prepared and administered by the language coordinator. Studying a foreign language in addition to Russian is desired and encouraged, but not required.

Sociology

https://www.sociology.northwestern.edu/graduate/

Degree Types: PhD

The Doctoral Program in Sociology (https://www.sociology.northwestern.edu/graduate) has particular strength in several substantive specialties – the sociology of culture; social organization, institutions, and social movements; sexualities; social inequality, labor markets, race, and gender; comparative and historical sociology; law and society; economic sociology – and we welcome research that falls outside of these areas as well.

Degrees Offered
- Sociology PhD (p. 104)
- Management and Organizations and Sociology PhD (p. 79)
- JD/PhD Combined Degree (https://catalogs.northwestern.edu/law/programs/jd/options/jdphd)
Sociology PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's
The Department of Sociology does not offer a terminal MA degree. Sociology PhD students may apply for a master's degree en route to their PhD. The Department of Sociology requires that all departmental required courses be completed, and second year paper be approved, as part of these 9 graded courses.

PhD
Total Units Required: 20 Units (plus 2 quarters of SOCIOL 480-0 Introduction to the Discipline)

For detailed information on The Sociology Department's PhD Program requirements please see the Sociology Graduate Student Handbook (The Whole Hooey (https://www.sociology.northwestern.edu/graduate/graduate-student-resources.html)). The general requirements are for students to take the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Coursework (8 Units)</td>
<td></td>
</tr>
<tr>
<td>Statistics Courses (2 Units)</td>
<td></td>
</tr>
<tr>
<td>SOCIOL 401-1</td>
<td>Statistical Analysis of Social Data: Applied Regression Methods I (Required)</td>
</tr>
<tr>
<td>SOCIOL 401-2</td>
<td>Statistical Analysis of Social Data: Applied Regression Methods II (Required)</td>
</tr>
<tr>
<td>Theory Courses (2 Units)</td>
<td></td>
</tr>
<tr>
<td>SOCIOL 406-1</td>
<td>Classical Theory in Sociological Analysis (Required)</td>
</tr>
<tr>
<td>One additional theory course</td>
<td></td>
</tr>
<tr>
<td>Methods Courses (2 Units)</td>
<td></td>
</tr>
<tr>
<td>SOCIOL 403-0</td>
<td>Field Methods (Required)</td>
</tr>
<tr>
<td>One additional methods course</td>
<td></td>
</tr>
<tr>
<td>Teaching Seminar (1 Unit)</td>
<td></td>
</tr>
<tr>
<td>SOCIOL 570-0</td>
<td>Seminar on College Teaching (Required)</td>
</tr>
<tr>
<td>Non-credit Proseminar</td>
<td></td>
</tr>
<tr>
<td>SOCIOL 480-0</td>
<td>Introduction to the Discipline (Fall and Winter Quarters Required)</td>
</tr>
<tr>
<td>Second-Year Paper Seminar (1 Unit)</td>
<td></td>
</tr>
<tr>
<td>SOCIOL 490-0</td>
<td>Research: Second Year Paper (Fall Quarter Required)</td>
</tr>
<tr>
<td>Electives (12 Units)</td>
<td></td>
</tr>
<tr>
<td>Sociology Department Electives (9 Units)</td>
<td></td>
</tr>
<tr>
<td>Outside Department Electives (3 Units)</td>
<td></td>
</tr>
</tbody>
</table>

Other PhD Degree Requirements
- Research/Projects: Second-year paper suitable for publication (may be used as master’s thesis; see below)
- Examinations: Qualifying examination for admission to candidacy is the Special Fields Paper that must be completed at the end of 3rd year.
- PhD Dissertation: Based on original, independent research
- Final Evaluations: Defense of dissertation

Spanish and Portuguese PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master's
The department does not admit students for the MA degree, but will award the MA to a PhD candidate if deemed in the student’s best interest.

Terminal MA
In some cases, students may be advised by the end of winter quarter of their second year that they should complete a terminal MA rather than continue on to the PhD degree. The requirements must be completed by the end of the second year. They are:
- Language proficiency in Portuguese and Spanish
- Minimum of 12 credits including at least 3 courses at the 400-level or above
- A 20 to 30-page paper to be evaluated by the Graduate Studies Committee
- Funding ends immediately upon recommendation for the terminal MA. The master’s thesis must be completed by the end of the spring quarter with a minimum of 3.0 GPA

PhD
Total Units Required: 18

Course Work and Academics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td></td>
</tr>
<tr>
<td>Summer Language Training Advised</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
</tr>
<tr>
<td>Two SPANPORT courses</td>
<td></td>
</tr>
<tr>
<td>One elective</td>
<td></td>
</tr>
<tr>
<td>Second language diagnostic exam</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td></td>
</tr>
<tr>
<td>Two SPANPORT courses</td>
<td></td>
</tr>
</tbody>
</table>

Spanish and Portuguese
https://www.spanish-portuguese.northwestern.edu/
The Master of Fine Arts in Stage Design program (https://communication.northwestern.edu/departments/theatre/programs) at Northwestern University prepares a select group of scenery, costume, and lighting designers for professional careers in the American Theatre, international theater and related design fields. Central to this three-year program of study is an emphasis on intensive collaboration between designers and directors, rigorous analysis of texts, thorough research and a fervent effort to nurture unique artistic voices. It is our belief that passionate, insightful artists immersed in a team-based environment, will generate bold, compelling theatrical works.

The first year of study emphasizes the importance of skills, training, and design process. The second year prioritizes collaboration, research, and imagination and serves as a transition from the activities and points of view of the entering student to the professional profile and attitudes of the graduating designer. The final year’s activity concentrates on designing and the preparation of the thesis portfolio.

The MFA in stage design is a terminal degree program requiring thirty-three academic units over nine quarters during a three-year residency. The MFA degree is granted upon completion of the program with a minimum grade point average of “B” and successful presentation of a design thesis portfolio. The portfolio must show clear evidence of mastery of the full range of graphic and conceptual support skills in the student’s major area(s) of concentration and an acquisition of fundamental skills in the secondary design area(s). Two additional years are allowed for the successful preparation, presentation and defense of the MFA thesis portfolio.

At the end of the first two years of study, each student is required to successfully present a portfolio to the faculty illustrating and articulating his/her development and vision as an artist and designer.

Please visit the MFA in Stage Design website (https://communication.northwestern.edu/programs/mfa_stage_design) or view our Design Photos slideshow.

 Degrees Offered
• Stage Design MFA (p. 105)

## Stage Design MFA

### Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

### Master’s

**Total Units Required: 33**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>THEATRE 312-0</td>
<td>Text Analysis</td>
</tr>
<tr>
<td>THEATRE 321-1</td>
<td>Advanced Design Process: Scene</td>
</tr>
<tr>
<td>THEATRE 321-2</td>
<td>Advanced Design Process: Costume</td>
</tr>
<tr>
<td>THEATRE 321-3</td>
<td>Advanced Design Process: Lighting</td>
</tr>
<tr>
<td>THEATRE 325-1</td>
<td>Drawing and Painting for the Theatre: Graphic Arts for the Stage Designer</td>
</tr>
<tr>
<td>THEATRE 325-2</td>
<td>Drawing and Painting for the Theatre: Rendering the Theatrical Space</td>
</tr>
<tr>
<td>THEATRE 325-3</td>
<td>Drawing and Painting for the Theatre: Rendering the Theatrical Figure</td>
</tr>
<tr>
<td>THEATRE 325-4</td>
<td>Drawing &amp; Painting for the Theatre: Drafting</td>
</tr>
</tbody>
</table>
Faculty have specialties in diverse areas including experimental design, linear models, sample surveys, statistical theory, computational Bayesian inference, bioinformatics and computational biology, and analysis of qualitative data. They have interest and broad experience in the application of statistics to the biomedical sciences, social sciences, law, and public policy.

Students can tailor the program to meet academic interests and career goals, and cross-disciplinary work is encouraged. The program prepares students for careers as university teachers and researchers and as research statisticians in industry, government, and the non-profit sector.

**Degrees Offered**

- Statistics PhD (p. 107)
- Statistics MS (Ad Hoc Combined Degree) (p. 106)

**Statistics**

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**Ad Hoc Master of Science in Statistics Degree Program for Northwestern PhD Students**

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

The Department offers an Ad Hoc MS degree in Statistics for Northwestern doctoral students in other disciplines including (but not limited to) Economics, Political Science, Sociology, Psychology, Learning Sciences, and Human Development & Social Policy who wish to establish their qualifications in statistics and quantitative research methodology. To participate, students must meet The Graduate School's eligibility requirements to pursue an ad hoc combined degree (p. 8), complete the Master of Science in Statistics Degree Program Application (https://www.statistics.northwestern.edu/graduate/ms-degree/ms-program-application.html), and receive approval from their home department, the Department of Statistics, and The Graduate School.

**Requirements**

Accepted students are expected to take a total of 9 approved courses in a program and complete a culminating project. The 9 courses must be unique from the 9 courses the student will use to satisfy the TGS requirements for the PhD. Double counting is not permitted when satisfying the Graduate School requirements for each credential.

**Coursework:** Students are typically required to take STAT 320-1 Statistical Theory & Methods 1 and STAT 320-2 Statistical Theory & Methods 2 to provide a foundation in statistical theory. Students with advanced mathematics may take STAT 420-1 Introduction to Statistical Theory & Methodology-1 and STAT 420-2 Introduction to Statistical Theory & Methodology-2 instead with department approval. The remaining 7 courses are selected with the advice and approval of the student's home department and the MS program director. Note that the program may be completed entirely from courses taught in the Department of Statistics, but may include up to 3 courses from departments other than Statistics. Courses from outside the department must be approved by the MS program director.

**Culminating Project:** All MS candidates are required to complete a culminating activity project using statistics. This project is typically work that will be included in the student's PhD dissertation, but can also be a stand-alone project. After completing the coursework, students submit a proposal for a culminating project that is reviewed and approved by the
MS program director. Submission of a satisfactory culminating project completes the student’s degree work for the MS.

Statistics PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: 14-15

Required Coursework

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 350-0</td>
<td>Regression Analysis</td>
</tr>
<tr>
<td>STAT 351-0</td>
<td>Design and Analysis of Experiments</td>
</tr>
<tr>
<td>STAT 420-1 &amp; STAT 420-2 &amp; STAT 420-3</td>
<td>Introduction to Statistical Theory &amp; Methodology-1 and Introduction to Statistical Theory &amp; Methodology-2 and Introduction to Statistical Theory &amp; Methodology-3</td>
</tr>
<tr>
<td>STAT 425-0</td>
<td>Sampling Theory and Applications</td>
</tr>
<tr>
<td>MATH 450-1</td>
<td>Probability Theory &amp; Stochastic Analysis</td>
</tr>
<tr>
<td>MATH 450-2</td>
<td>Probability Theory and Stochastic Analysis</td>
</tr>
<tr>
<td>or IEMS 460-1 &amp; IEMS 460-2</td>
<td>Stochastic Processes I and Stochastic Processes II</td>
</tr>
</tbody>
</table>

Electives (300- and 400-level graduate courses in Statistics): 6 courses. At least 2 must be 400-level courses.

Other PhD Degree Requirements
- Examinations: Qualifying examination taken at the beginning of the second year; prospectus completed by the end of third year
- PhD Dissertation: based on independent research
- Final Evaluations: oral defense of dissertation

En Route Master's
Optional MS Degree for Statistics PhD Students
Students admitted to the PhD program can obtain an optional MS (master of science) degree en route. The MS degree requires 12 courses. Students choose from 300 and 400 level courses offered by the Statistics Department. Required are:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 350-0</td>
<td>Regression Analysis</td>
</tr>
<tr>
<td>STAT 351-0</td>
<td>Design and Analysis of Experiments</td>
</tr>
<tr>
<td>STAT 420-1 &amp; STAT 420-2 &amp; STAT 420-3</td>
<td>Introduction to Statistical Theory &amp; Methodology-1 and Introduction to Statistical Theory &amp; Methodology-2 and Introduction to Statistical Theory &amp; Methodology-3</td>
</tr>
<tr>
<td>STAT 425-0</td>
<td>Sampling Theory and Applications</td>
</tr>
</tbody>
</table>

Six courses from among other 300-level and 400-level Statistics courses, at least two must be 400-level

For the optional MS degree, students must also pass the qualifying exam offered at the beginning of the second year of the program. No thesis is required.

Technology and Social Behavior

http://tsb.northwestern.edu/index.php

Degree Types: PhD

The combined PhD in Communication and Computer Science, known as the PhD in Technology and Social Behavior (TSB) (http://tsb.northwestern.edu), provides training in social science methods to study human behavior and computer technology. Students design and implement new technologies, practice incorporating the results of empirical research into these technologies, and prepare for a wide range of academic and industrial jobs.

Students receive rigorous training in humanities, social sciences, human-computer interaction, and computer science methodologies. The curriculum combines requirements from Computer Science (https://www.mccormick.northwestern.edu/computer-science) in the School of Engineering and the Media, Technology & Society (MTS) PhD Program (https://communication.northwestern.edu/programs/phd_media_technology_society) in the School of Communication.

Students have the opportunity to spend summers carrying out research on the Evanston campus, or participate in research internships at companies such as IBM, Google, Facebook, and Microsoft.

The TSB program draws on Northwestern’s strong support for interdisciplinary study, benefits from talented faculty who contribute to a tradition of collaboration, and attracts unique students who are eager for academic experiences that cross school and department boundaries.

Degrees Offered
- Technology and Social Behavior PhD (p. 107)

Technology and Social Behavior PhD
Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: 20

The TSB doctoral program admits students from a variety of backgrounds and gives them rigorous training in humanities, social science and engineering methodologies, allowing them to understand technological developments in their broadest possible contexts. The implementation and production of media, information and communication technology—as well as the study of their contexts of use—is an expected part of the program of study. Accordingly, students should either have a technological background already, or be prepared to acquire the relevant skills early in their graduate program.

To complete the PhD in Technology and Social Behavior, students must complete coursework, pass qualifying examinations, and complete a thesis as detailed below.

Course Requirements
Critical evaluation of disciplinary perspectives, as well as integration of disciplinary methodologies, is a key goal of the TSB doctoral program. The required courses therefore provide theoretical, historical, psychological, and sociological perspectives on technology, along with classes in research methods. For the remaining courses, each student must work with an advisor to create a course of study that approaches
a single theme within technology and social behavior from multiple disciplines.

Because PhD students are encouraged to create a course sequence that best supports their research, dissertation, and teaching plans, each student will be assigned to a temporary advisor upon arrival, who will help design a research plan. Students need not, however, feel obliged to choose this person as a thesis advisor. The research plan will incorporate course requirements from both the School of Engineering programs and School of Communication, however since these degree requirements are quite flexible, students can expect to engage in hands-on research starting in their first year.

Computer Science and MTS both have flexible course requirements, demonstrating both departments’ support of independent programs. In the TSB combined degree program, 2 additional units are added to the overall PhD requirements: students must take qualifying examinations in both departments, and students must submit their PhD theses to a committee composed of faculty from both departments.

- The usual computer science requirements are as follows:
  - You are required to take 18 units for the PhD:
  - 16 departmental courses, and 2 COMP_SCI 590-0 Research Research units.
  - Of the 16 departmental courses six must be taken at the 400 or 500 level.
  - Exams and other requirements are defined by the track one is in (e.g., Graphics and Interactive Media, Cognitive Systems, etc.).
  - Courses from other departments (such as Learning Sciences, Psychology, etc) are often substituted for departmental courses.

- The usual MTS requirements are as follows:
  - You are required to take 18 units for the PhD:
  - 4 of the 18 units will be from courses internal to MTS
  - 2 of these units must be taught by two different faculty
  - The 3rd unit must be the MTS core course, "The Practice of Scholarship;"
  - 4 out of the remaining units will be from a minor area and may come from either within MTS or another department.
  - 1 course will be in implementation (from Computer Science, Learning Sciences, Engineering, Art & Technology, etc.).
  - The remaining units need not be confined to courses within MTS, but can be taken from other tracks within MTS or in departments across the University.

The TSB program combines the requirements of these departments in a 20-unit curriculum that includes the following:

- The MTS 501 first year research practicum.
- Two MTS course taught by 2 different faculty members.
- The MTS 503 course on "The Practice of Scholarship;"
- Two units of Comm_ST 499 and two units of COMP_SCI 499.
- A concentration in either the Cognitive Systems or Graphics and Interactive Media track. This concentration will be composed of 4 courses taken from one of those concentrations, and will define which qualifying exams the student takes in CS. This concentration will ensure that the student has a mastery of computing concepts and skills sufficient to pass the qualifying exams, and to subsequently write a thesis acceptable to CS. Examples of acceptable courses for CogSys are Artificial Intelligence Programming, Intelligent Information Systems, Knowledge Representation. Examples of acceptable courses for GIM are Design of Interactive Learning Environments, Computer Graphics, Computer Game Design.
- The remaining 8 course units can be taken in Computer Science, MTS or departments across the University (Learning Science, Engineering, Art & Technology, etc), including Independent Studies in Computer Science or MTS.

**Qualifying Exam**

Students in the TSB combined degree program will complete two nearly whole exams in the two distinct programs, as follows:

- Computer Science requires a qualifying exam in an area of specialization chosen from one of 5 areas in CS (Cognitive Systems, Graphics and Interactive Media, Phototonics, etc). Each area designs its own exam, details of which can be found in the Computer Science graduate manual. The qualifying exam tests for computing concepts and skills.
- MTS requires 3 qualifying exams: one Major Field and two Minor Fields. Major Field requirement: A student will demonstrate mastery of his or her Major Field by completing a significant piece of original work in the area, expected to be of publishable quality or a “dry-run” for the dissertation. Minor Fields requirement: In the Minor Fields, students will be expected to demonstrate mastery of a body of literature, which could range from a 24-hour take home essay examination to a week-long project. The specific details of each field examination will be arranged by each student in consultation with his or her Examination Chair."

In the TSB combined degree program these requirements are modified as follows:

- Students take the CS qualifying exam in Cognitive Systems or in Graphics and Interactive Media, substituting one of the required questions, and one of the optional questions with the MTS major qualifying exam.
- Students take the MTS qualifying exam by completing the Major Field area of the MTS exam, and one Minor Field area. The Computer Science exam will act as the second Minor Field area.

The Examination Chair will help establish the details of the exams. Qualifying exams must be completed before the beginning of the student’s 4th year in the program.

**Thesis**

Theses in Computer Science are mostly composed of an implemented system, while theses in Communication require empirical research that addsuce evidence for a hypothesis. PhD theses in TSB, the combined PhD in Computer Science and Communication, will comprise two parts that are not often found together – an implementation, and a hypothesis about how the implemented system affects social behavior, with an empirical evaluation of that hypothesis.

In order to ensure that the PhD thesis represents dual competence in Computer Science and Communication, thesis committees are composed of four faculty members, of whom two are in Communication and two are in Computer Science. Three of the committee members must be faculty at Northwestern University. The thesis must be judged acceptable by all four of these committee members.
Theatre & Drama
https://iptd.northwestern.edu

Degree Types: PhD

The Interdisciplinary PhD in Theatre and Drama (IPTD) is a cross-school program featuring faculty and coursework that span the Humanities, Social Sciences, and Visual and Performing Arts. We train outstanding students for lifetime careers both within and beyond the academy, emphasizing the simultaneous development of intellectual excellence in scholarship with pedagogical skills. We seek students with exceptional promise as researchers who may also have backgrounds in theatre, dance, or performance in order to examine historical and contemporary theatrical practice from multi- and inter-disciplinary perspectives.

IPTD gives students the opportunity to choose classes and work with professors from any department in the School of Communication or the Weinberg College of Arts and Sciences, while providing a home base in the Department of Theatre. Individual students in IPTD work with a committee unique to their interests and, in consultation with the Director of Graduate Studies and their advisors, design a program of study incorporating theatre, dance, or performance research with one or more other academic fields.

Students in this program are encouraged to participate in TGS’s Interdisciplinary Initiative program. For more information on how you can have a second intellectual “home” outside of your department or program, please visit the Interdisciplinary Clusters page (https://www.tgs.northwestern.edu/academics/programs/clusters-and-certificates).

The Department of Theatre also offers MFA programs in Acting (https://acting.northwestern.edu), Directing (p. 54), and Stage Design (p. 105).

Degrees Offered
• Theatre & Drama PhD (p. 109)

Theatre & Drama PhD

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD

The PhD in Theatre and Drama consists of 18 course units, including six required core courses that emphasize a breadth of historical coverage as well as significant methodological inquiry into historical and theoretical practices. Courses satisfying these requirements are identified each year by the Director, and only those so approved can satisfy the requirement.

Coursework Requirements
Total Units Required: 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH&amp;DRAMA 501-0</td>
<td>Doctoral Studies in Theatre &amp; Drama (Research Methods and Methodologies)</td>
</tr>
<tr>
<td>TH&amp;DRAMA 502-0</td>
<td>Topics in Theatre (Research Design and Prospectus)</td>
</tr>
</tbody>
</table>

At least one 400-level or 500-level course in each area below:

- European theatre and drama prior to 1650
- Performance theory
- Theatre and drama of the Americas, Africa, or Asia

Electives (12 units)

*Courses satisfying these requirements must have prior approval of the program director.

Other PhD Degree Requirements

• Examinations: late in second year or early in third year, qualifying examination for admission to candidacy consisting of three three-hour written sections followed by one two-hour oral examination; examination materials focus on reading lists identifying (usually) three examination fields approved by the student’s dissertation committee and the IPTD Executive Committee
• PhD Dissertation: written dissertation and oral defense
• Other: at the beginning and end of the academic year the student submits a statement of current progress and goals on GSTS, which is added to the student’s program record; the Executive Committee reviews these statements each year and makes recommendations to program director and in written statements to student

Theoretical and Applied Mechanics
https://www.mccormick.northwestern.edu/theoretical-applied-mechanics/

Degree Types: PhD, MS

The interdisciplinary Graduate Program in Theoretical and Applied Mechanics (https://www.mccormick.northwestern.edu/theoretical-applied-mechanics) (TAM) combines many disciplines in the McCormick School of Engineering and Applied Science including civil and environmental engineering, mechanical engineering, biomedical engineering, and materials science. Qualified students of engineering, mathematics, physics, or an allied science may pursue the MS or PhD in solid mechanics or fluid mechanics.

Specific applications of mechanics research include nanotechnology, soft matter, cell mechanics, composite materials, multiscale modeling, sensor development, nondestructive evaluation, transportation materials and vehicles, earthquake, and material and structural design with uncertainty quantification.

Colloquia and seminars with world-renowned researchers are regularly scheduled in association with the program.

Degrees Offered
• Theoretical and Applied Mechanics MS (p. 109)
• Theoretical and Applied Mechanics PhD (p. 110)

Theoretical and Applied Mechanics MS

Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s
Total Units Required: 12
Programs of study are determined on an individual basis between the student and the advisor of the home department. All courses must be approved by the advisor.

Other MS Degree Requirements
- Examinations: final oral comprehensive examination on master’s thesis or on report of research project
- Research/Projects: with approval of advisor, report on research project may serve in lieu of master’s thesis
- Other: none

Theoretical and Applied Mechanics PhD

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

PhD
Total Units Required: 15
(Units required are beyond the BS degree, excluding projects and master’s thesis.)

Programs of study are determined on an individual basis between the student and the advisor of the home department. All courses must be approved by the advisor.

Other PhD Degree Requirements
- Examinations: oral qualifying examination prior to admission to candidacy
- Research/Projects: none specified
- PhD Dissertation: dissertation in area of solid or fluid mechanics
- Final Evaluations: oral defense of dissertation

Writing for the Screen and Stage

https://communication.northwestern.edu/programs/mfa_writing_screen_stage/welcome

Degree Types: MFA

The MFA Program in Writing for the Screen and Stage (https://communication.northwestern.edu/programs/mfa_writing_screen_stage/welcome) trains leaders in the fields of screen/television and playwriting who will help form the entertainment industry of the future. Graduates leave with a deep understanding of media writing; familiarity with production concepts, equipment, and techniques; and an understanding of the universals that connect all media narratives.

The program focuses on writing and storytelling, and also includes a production component. It provides opportunities for students to produce their own work, both at Northwestern and through arrangements with theatrical and film companies in the greater Chicago area. Students also participate in internships and classes in Hollywood, New York, and Chicago.

By graduation, students will have created a short screenplay, a full-length play, a television pilot, and a full-length project of their choosing.

Degrees Offered
- Writing for the Screen and Stage MFA (p. 110)

Writing for the Screen and Stage MFA

Degree Requirements
The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (p. 7).

Master’s
Total Units Required: 18

Course | Title
--- | ---
RTVF 561-0 | Foundations of Writing for Screen & Stage
RTVF 562-0 | Writing the Short Play
RTVF 563-0 | Writing the TV Episode
RTVF 564-0 | Full Length Project (Feature Thesis 1)
RTVF 565-0 | Full-length Project II (Feature Thesis 2)
RTVF 566-0 | Full-length Project III (Feature Thesis 3)

Topics Courses
RTVF 360-0 | Topics in Media Writing (or other media writing electives with approval of the Director of the MFA)
RTVF 464-0 | Advanced Media Writing

Sample courses include:
- Writing the Production-Ready Short Film
- Writing Romantic Comedy
- The Art, Business, and Ethics of Assignment Writing
- Writing Horror/Fantasy/Supernatural
- Writing the Dramatic Pilot
- Writing the Comedy Screenplay
- Writing the ½ Hour Spec Script
- Writing the Sci-Fi Script
- Advanced Sitcom Writing
- Writing the Anti-Hero
- Writing the Fact-Based Drama
- LGBTQIA for Theater, TV, and/or Web
- Improv for Writers
- Pitching the TV Series
- Writing and Performing Stand-Up
- Political Drama Between Stage and Screen
- Writing the Historical Drama
- Activist Video for the Web
- Creativity and Flow in Screenwriting
- Writing the Feature Film
- Workshopping the Full-Length Project
- Writing Styles
- Advanced Scene Workshop

Production Course
RTVF or Theatre (300-level or higher) with the approval of the Director of the MFA.

Theory/history/culture Courses (300-level or higher)
From Screen Cultures/RTVF, Performance Studies, Art Theory and Practice, Theatre, or other departments with approval of MFA program director.

Electives
From Production, Screen Cultures, or Writing/RTVF, Performance Studies, Art Theory and Practice, Theatre or other departments with approval of MFA program director. Maximum of two screenwriting, playwriting or television writing electives.
Internship

<table>
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<td>Summer Internship Seminar</td>
</tr>
<tr>
<td>RTVF 490-2</td>
<td>Fall Internship Capstone</td>
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2. With an emphasis on understanding the structure of a feature play, film, innovative theatre piece, or interactive narrative (student’s choice) Students produce: Outline, first act.
3. With an emphasis on writing the first draft.
4. With an emphasis on adaptation, revision, and preparing the writer for the business of writing.

Other MFA Degree Requirements

MFA students will be allowed to take a maximum of 20 credits.

Grade average: Students must maintain a B average. If a student’s average is not a B or higher by the end of the first year, he or she may be asked to leave the program.

Final portfolio Review/Defense: In consultation with the Director of the Program, each student will choose a committee of two faculty members to review his/her final portfolio (at least 3 substantial scripts created within the context of courses) and to judge his/her final defense of that portfolio.
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Accounting and Information Systems (ACCT)

ACCT 540-1 Empirical Research in Accounting I (1 Unit)
Students will become acquainted with research questions, methodologies, and findings of empirical research on the implications of accounting information for capital markets through journal readings, replications of existing research, and a final exam. The goal is for students to develop skills in issue identification and research design that can be used to do research and to evaluate research of others.

ACCT 540-2 Empirical Research in Accounting II (1 Unit)
This course focuses on examining and evaluating the economic arguments underpinning capital markets based, empirical accounting research. The course includes discussion and critical assessment of research designs and statistical methods used by accounting researchers with a focus on the appropriateness of the research question. Students are responsible for presenting research papers and preparing a final research proposal.

ACCT 550-1 Research in Accounting Theory I (1 Unit)
This course provides an introduction to contemporary research in financial accounting theory and is designed for PhD students in Accounting, Economics, and related disciplines. The course analyzes models of voluntary and mandatory disclosures, the design of accounting standards, income measurement, earnings management, and auditing.

ACCT 550-2 Research in Accounting Theory II (1 Unit)
Students study economic models of financial reporting and disclosure together with the economics of accounting standards. The course includes study of the linkages among financial accounting, managerial accounting and auditing. Students learn to evaluate the existing models in the literature and to construct basic models of their own.

ACCT 590-0 Research (3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

African American Studies (AF_AM_ST)

AF_AM_ST 401-0 Research Seminar in Black Studies (1 Unit)
Introduction to central debates in Black Studies on a graduate level. Emphasizes critical thinking, research design and method, forms of argumentation, and theory building. Readings highlight a range of methods—historiographic, literary, ethnographic, social scientific etc. Assignments focused on developing student independent research projects.

AF_AM_ST 402-0 Theorizing Black Genders and Sexualities (1 Unit)
Examines the multiple and changing meanings and political effects of gender and sexuality on Black identity in different socio-cultural contexts. Puts in dialogue global Black feminist theory and Black queer theory through the discussion of topics such as: slavery, colonialism, diaspora, citizenship, activism, labor, kinship, desire, art, reproduction, violence, and others.
AF_AM_ST 403-0 Theorizing Blackness and Diaspora (1 Unit)
Introduces students to cultural, social, historical, artistic, and theoretical approaches to developing a global analytics of Blackness. Surveys Blackness as a category of critical analysis for both historical and contemporary social formations in the African Diaspora. Considers how gender, class, sexuality, and nationality shape the territory of Blackness.

AF_AM_ST 410-0 Black Feminist and Black Queer Theories (1 Unit)
Team taught course stages a dialogue of approaches within US black feminist theory and black queer theory through the discussion of such topics as the legacy of slavery; activism; work, family, and self-esteem; body politics, i.e., sexuality, reproduction, HIV/AIDS, popular culture representation; appropriations and alliances.

AF_AM_ST 420-0 Expressive Arts and Cultural Studies (1 Unit)
Utilizes slave narratives, fiction, poetry, music, drama, critical theory, and the visual arts to survey how African-descended writers, artists, and theorists have grappled with such issues as: the relationship to Africa; self-articulation and struggle; performance as a site of knowledge production and contestation; and the global circulation of Black cultural production.

AF_AM_ST 440-0 Black Historiography (1 Unit)
Interrogates the development of Black History and its writing. Introduces graduate students to key themes, debates, sources, methods, periods and events that have shaped the emergence of Black Historiography. Examines historical methodology, including the histories of archives, their sources, and the challenges faced by historians seeking to uncover the Black past.

AF_AM_ST 441-0 History of Black Women in the Diaspora (1 Unit)
Examines the voices, struggles, theorizing, leadership, and writings of Black women, individually and collectively, locally and in Diaspora. Interrogates and challenges definitions of Black women by probing categories of difference, including ethnicity, religion, class, sexuality, gender identity, spirituality, and migrant/immigrant status.

AF_AM_ST 442-0 Africans in Colonial Latin America (1 Unit)
Historiography of Africans and their descendants in Latin America, from early colonial times to abolition. Focusses on a series of historical problems affecting Africans, including the realities of slavery, free black life, gender and sexuality, culture, and questions of identity formation.

AF_AM_ST 444-0 Civil Rights/Black Liberation (1 Unit)
Surveys the scholarship on what many historians have termed “the long Civil Rights Movement.” Begins with the labor activism of the 1930s and the global wars of the 1940s, and treats the U.S. Black Freedom Movement as part of the broader anti-colonial upheaval of the 20th century.

AF_AM_ST 445-0 Historicizing Race in Latin America (1 Unit)
Surveys the principle themes, sources, methods and arguments animating scholarship on race, sexuality, and modernity in Latin America.

AF_AM_ST 460-0 Race, Politics, Society, and Culture (1 Unit)
Uses texts from sociology, anthropology, political science, and other social sciences to consider how the concepts of “race” and “Blackness” have functioned across time and space. Explores how race and Blackness reflect, inflect and inscribe inequality as well as group consciousness, struggle, and everyday life.

AF_AM_ST 467-0 Ethnographies of Immigration, Race, and Ethnicity (1 Unit)
Interdisciplinary examination of texts for their theoretical, contextual, and methodological approaches to immigration, race, and ethnicity. Themes include the politics of location, representation, and fieldwork.

AF_AM_ST 469-0 Poststructuralism and Black Political Thought (1 Unit)
Developing theoretical perspectives on the conceptualization of Black politics in the work of different Black thinkers, using the poststructuralist distinction between ‘politics and the political’.

AF_AM_ST 475-0 Genealogy of Racism as a Concept: Deconstruction & Governmentality (1 Unit)
Interrogates the histories and logics of racism as a concept since its formulation and formation during the early 20th century. Critiques the discursive traditions in which racism has been traditionally narrated as a historically self-evident object of moral condemnation or political critique.

AF_AM_ST 480-0 Graduate Topics in African American Studies (1 Unit)
Explores special topics pertinent to Black Studies. Content changes with instructor.

AF_AM_ST 490-0 Independent Study (1 Unit)
Individualized reading, research, discussion, and/or writing with faculty member.

AF_AM_ST 491-0 Reading and Pedagogy (1 Unit)
Individualized training and practice as a teaching assistant (TA). Students registered for 491 and 2 other courses are considered full time.

AF_AM_ST 590-0 Research Seminar (1-3 Units)
Independent research in first two years of PhD program, including summers. Students registered for 590 and 2 other courses are considered full time.

African Studies (AFST)

AFST 390-0 Topics in African Studies (1 Unit)
A general examination of topics relevant to African studies. May be repeated for credit with change of topic. Restricted to students in Northwestern’s South Africa program.

AFST 483-0 African Studies Seminar (1 Unit)
AfriSem - An interdisciplinary, research-based forum for students studying Africa. Participants gain insight from faculty and peers across academic departments and regional and thematic focus. Sessions include student presentations of research and works-in-progress; methodological discussions; preparation for field work; and professional development. Participation throughout the academic year required to receive credit.

Anthropology (ANTHRO)

ANTHRO 306-0 Evolution of Life Histories (1 Unit)
Evolved strategies for allocating resources among growth, reproduction, and maintenance; emphasis on the biological processes underlying the human life cycle and its evolution.

ANTHRO 310-0 Evolution and Culture (1 Unit)
Introduction to the application of theory from evolutionary biology to cultural anthropology; principles of evolutionary biology; application of principles to human social behavior and culture. Prerequisite: ANTHRO 213-0 or equivalent.

ANTHRO 311-0 Indians of North America (1 Unit)
Aboriginal cultures of northern Mexico, continental United States, Alaska, and Canada. Languages, art, and social, economic, and religious life. 

ANTHRO 312-0 Human Population Biology (1 Unit)
Current theory and research in human biological diversity, focusing on the impact of ecological and social factors on human biology; how adaptation to environmental stressors promotes human biological variation. Prerequisite: ANTHRO 213-0.
Natural Sciences Distro Area

ANTHRO 313-0 Anthropological Population Genetics (1 Unit)
Principles of population genetics applied to primates. Mathematical models, analyses of small populations, and interaction of social and genetic processes. Prerequisite: consent of instructor.

ANTHRO 314-0 Human Growth & Development (1 Unit)
Integrated biological and cultural perspective on human growth and development from infancy through adolescence; cross-cultural variation in developmental processes and outcomes. Prerequisite: 100-or 200-level anthropology, biology, or psychology course or consent of instructor.

ANTHRO 315-0 Medical Anthropology (1 Unit)
Theories of interactions between culture and biology that affect human health. Beliefs and practices for curing illness and maintaining wellbeing. Cross-cultural study of infectious and chronic diseases, mental illness, infant/maternal mortality, poverty, and gender. Prerequisite: 100-or 200-level anthropology or sociology course or consent of instructor.

ANTHRO 317-0 Human Evolution (1 Unit)
Fossil record and reconstruction of phylogeny; morphological and behavioral adaptation of early hominids and forebears.

ANTHRO 318-0 Material Worlds of the Middle Ages (1 Unit)
Landscapes, buildings, and material culture of medieval Europe, as seen through archaeology and related disciplines.

ANTHRO 319-0 Material Life & Culture in Europe, 1500-1800 (1 Unit)
Landscapes, buildings, and material culture of early modern Europe, as seen through archaeology and related disciplines.

ANTHRO 320-0 Peoples of Africa (1 Unit)
A survey of the cultures of Africa and the significant similarities and differences among the indigenous societies of the continent.

ANTHRO 321-0 Archaeological Field Methods (1 Unit)
Practical training in basic methods and techniques at an excavation site; given with summer Archaeology Field School.

ANTHRO 322-0 Introduction to Archaeology Research Design & Methods (1 Unit)
Regional and site-specific approaches to the description and analysis of patterns in archaeological data, including settlement survey, site characterization, vertical excavations, and horizontal household excavations.

ANTHRO 325-0 Archaeological Methods Laboratory (1 Unit)
Analysis of archaeological methods (faunal, botanical, artifact, or soil analysis) with various techniques. May be repeated for credit.

ANTHRO 327-0 Archaeology of Ethnicity in America (1 Unit)
History of different ethnic groups in America as shown through living quarters, burials, food remains, tools, jewelry, etc. How groups have been portrayed in museums claiming to depict the American past. Focus on African Americans and Native Americans.

ANTHRO 330-0 Peoples of the World (1 Unit)
Comparative ethnography of a regionally or historically associated group of cultures or a type of community defined in ecological, ideological, or other terms. May be repeated for credit.

Social Behavioral Sciences Distro Area

ANTHRO 332-0 The Anthropology of Reproduction (1 Unit)
Marriage and reproduction throughout the world, particularly the developing world and Africa. Conjugal strategies, fertility, contraception.

ANTHRO 334-0 The Anthropology of HIV/AIDS: Ethnographies (1 Unit)
The experiences of HIV-positive people; local and global policies shaping access to treatment; contributions of anthropologists to reducing HIV/AIDS globally. Readings from classic and current ethnographies. Prerequisite: 300-level course in anthropology or sociology.

ANTHRO 339-0 Material Culture (1 Unit)
Relationship between material objects and social life; review of theoretical approaches to gifts and commodities; ethnographic collecting in colonial and postcolonial settings; relationship between culture and aesthetics. Prerequisite: ANTHRO 211-0 or consent of instructor.

ANTHRO 341-0 Economic Anthropology (1 Unit)
Economic organization in small-scale non-industrialized communities. Traditional structures of primitive and peasant economies.

ANTHRO 350-0 Anthropology of Religion (1 Unit)
The human relationship with the supernatural. Action patterns accompanying beliefs. Comparison of nonliterate religions and historical religions.

ANTHRO 354-0 Gender and Anthropology (1 Unit)

ANTHRO 355-0 Sexualities (1 Unit)
Cross-cultural survey of sexuality from an anthropological perspective. Focus on first half of the 20th century, the 1970s, 1980s, and the turn of the 21st century.

ANTHRO 360-0 Language and Culture (1 Unit)
Relationship between language and culture; language as the vehicle of culture and as the manifestation of thought.

ANTHRO 361-0 Talk as Social Action (1 Unit)
Analysis of talk in interaction based on examination of audio and video recorded data and associated transcripts. Conversation, action, turn, sequence, relevance, social structure, qualitative methodologies. Prerequisite: ANTHRO 215-0 or consent of instructor.

ANTHRO 362-0 Advanced Methods in Quantitative Analysis (1 Unit)
Advanced applications of univariate and multivariate statistics to anthropological research questions. Prerequisite: 200-level statistics course.

ANTHRO 370-0 Anthropology in Historical Perspective (1 Unit)
Major schools of thought in social, archaeological, and biological anthropology over the last century.
ANTHRO 386-0 Methods in Human Biology Research (1 Unit)
Laboratory-based introduction to international research in human biology and health; methods for assessing nutritional status, physical activity, growth, cardiovascular health, endocrine and immune function. Prerequisite: ANTHRO 213-0 or consent of instructor.

ANTHRO 389-0 Ethnographic Methods and Analysis (1 Unit)
Descriptive, naturalistic study of the culture of human social groups. Data gathering through observation and interview. Data analysis for ethnographic reporting. Prerequisites: ANTHRO 211-0 and ANTHRO 215-0.

ANTHRO 390-0 Topics In Anthropology (1 Unit)
Advanced work in areas of developing interest and special significance. May be repeated for credit with different topic.

ANTHRO 391-0 Archaeology, Ethics, and Contemporary Society (1 Unit)
Why study of the past is relevant to the present; examination of ethical issues in archaeology as they arise during the fieldwork experience. Prerequisite: ANTHRO 321-0.

ANTHRO 396-0 Advanced Archaeological Field Methods (1 Unit)
Complex excavation and survey procedures, topographic map making, excavation drawing, soil description; offered in conjunction with the summer Archaeology Field School.

ANTHRO 401-1 Logic of Inquiry in Anthropology (Bio) (1 Unit)
Advanced introduction to the core of anthropology for beginning graduate students.

ANTHRO 401-2 Logic of Inquiry in Anthropology (Archy) (1 Unit)
Advanced introduction to the core of anthropology for beginning graduate students.

ANTHRO 401-3 Logic of Inquiry in Anthropology (Cultural) (1 Unit)
Advanced introduction to the core of anthropology for beginning graduate students.

ANTHRO 401-4 The Logic of Inquiry in Anthropology (Ling) (1 Unit)
Advanced introduction to the core of anthropology for beginning graduate students.

ANTHRO 424-0 Seminar in Biological Anthropology (1 Unit)
Presentation and discussion of topics in biological anthropology, including graduate student and faculty research interests, new literature, and reports on current meetings.

ANTHRO 430-0 Integrative Seminar in Society, Biology, and Health (1 Unit)
Survey of efforts to understand the dynamic relationships among society, biology, and health, with emphasis on confronting epistemological and methodological challenges to successful interdisciplinary scholarship on health in an era of increasing specialization.

ANTHRO 470-0 History of Anthropological Theory (1 Unit)
Social/cultural anthropology during the past 150 years; philosophical and historical roots of the subject.

ANTHRO 472-0 Seminar in Political Anthropology (1 Unit)
Anthropological approaches to cross-cultural study of politics and political organization. Themes include evolutionary and historical frameworks; political processes; kinship, ethnicity, and religion; political change, colonialism, and the world system.

ANTHRO 473-0 Seminar in Economic Anthropology (1 Unit)
Anthropological approaches to the study of economic life. Case studies and theoretical works address the development of economic anthropology and its relationship to the rest of the discipline and to other social sciences.

ANTHRO 474-0 Seminar in Religion and Values (1 Unit)
Philosophical and methodological problems that relate to cultural anthropology. Approaches to the analysis of cosmology, ritual, and myth; comparison of scriptural and nonscriptural religions.

**ANTHRO 475-0 Seminar in Contemporary Theory (1 Unit)**
Recent trends in social theory. Examines work from outside as well as within anthropology, as it has contributed to debate within the discipline: e.g., structuralism, practice theory, postmodernism.

**ANTHRO 476-0 Globalization & Discontents (1 Unit)**
Analysis of the globalization phenomenon from historical political-economic perspective. Neoliberalism, increasing global inequality, race, gender, nationalism, migration, labor and commodity chains, roles of NGOs, anti-globalization politics.

**ANTHRO 477-0 Race/Ethnicity, Gender, & Nationality (1 Unit)**
An anthropological, political-economic and history of thought perspective on the related phenomena of race/ethnicity, gender, and nationalism from the nineteenth century to the present.

**ANTHRO 478-0 Critical Americanist Ethnographies (1 Unit)**
The history and present reality of ethnographic work on the non-Native American urban US since the 1910s. This seminar works interdisciplinary and historically reframing the "anthropology of the US". History of American anthropology and popular political culture, the culture and political economy of American cities, of embedded race/ethnicity, immigration, and gendered realities with material on health, environment, and education.

**ANTHRO 484-0 Seminar in Linguistic Anthropology (1 Unit)**
Advanced seminar featuring a select topic in linguistic anthropological theory and praxis. Topics will incorporate perspectives about political economy, gender, race, ethnicity, class, and social inequality.

**ANTHRO 485-0 Seminar in Mind, Body, & Health (1 Unit)**
Mind, Body, and Health: Critical evaluation of hidden epistemologies embedded within cultural constructions of mind and body, health and illness. Examination of cultural, social, and political-economic influences on health and exploration of the concept of embodiment. Comparative investigation of how humans cope with pain, illness, and suffering.

**ANTHRO 486-0 Evolution & Biological Anthropology (1 Unit)**
History of evolutionary thought; the development of biological anthropology.

**ANTHRO 490-0 Topics in Anthropology (1 Unit)**
Presentations by department faculty on contemporary topics of importance to the development of anthropology. May be repeated for credit with change of topic.

**ANTHRO 496-0 Bridging Seminar (1 Unit)**
Advanced course designed to integrate topics from the four subfields of anthropology (archaeology, biological anthropology, cultural anthropology, and linguistic anthropology). May be repeated for credit.

**ANTHRO 499-0 Independent Study (1-3 Units)**
Permission of instructor and department required. May be repeated for credit.

**ANTHRO 519-0 Responsible Conduct of Research Training (0 Unit)**
Training in the Responsible Conduct of Research to fulfill the University requirement. This includes online CITI training and completion of an approved course with 4 hours of in person instruction.

**ANTHRO 570-0 Anthropology Seminar (TA Credit) (1 Unit)**
Special topics. May be repeated for credit with change of topic.

**ANTHRO 590-0 Research (1-3 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. See Dept for Section and Permission Numbers.

### Applied Physics (APP_PHYS)

**APP_PHYS 499-0 Independent Study (1-3 Units)**
See Dept for section number - May be repeated for credit. Permission of instructor required.

**APP_PHYS 590-0 Research (1-3 Units)**
See Dept for section number - Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

### Arabic (ARABIC)

**ARABIC 410-0 Advanced Study (1 Unit)**

### Art History (ART_HIST)

**ART_HIST 310-1 Ancient Art: Greece (1 Unit)**
Art and architecture of the Ancient Greco-Roman World. Greece from the prehistoric Aegean to the Hellenistic periods. Prerequisite: 200-level art history course. Literature Fine Arts Distro Area

**ART_HIST 310-2 Ancient Art: Greece (1 Unit)**
Art and architecture of the Ancient Greco-Roman World. Greece from the prehistoric Aegean to the Hellenistic periods. Prerequisite: 200-level art history course. Literature Fine Arts Distro Area

**ART_HIST 320-2 Medieval Art: Early Medieval (1 Unit)**
Art and architecture of the Middle Ages. Early medieval. Literature Fine Arts Distro Area

**ART_HIST 329-0 Special Topics in Medieval Art (1 Unit)**
Content varies-for example, the early Christian church; history of illuminated manuscripts; pilgrimage and saints’ cults; the cathedral; Spain; art and crusade. Prerequisite: 200-level art history course.

**ART_HIST 330-1 Renaissance Art c. 1300-1550 (High Renaissance) (1 Unit)**
Painting, sculpture, architecture, and the graphic arts in Europe from c.1300-1550 (High Renaissance). Prerequisite: 200-level art history course. Literature Fine Arts Distro Area

**ART_HIST 330-2 Renaissance and Mannerism: Southern European Art 1400-1600 (1 Unit)**
Painting, sculpture, architecture, and the graphic arts in Southern Europe from 1400-1600. Prerequisite: 200-level art history course. Literature Fine Arts Distro Area

**ART_HIST 330-3 Renaissance and Mannerism: Northern European Art 1400-1600 (1 Unit)**
Painting, sculpture, architecture, and the graphic arts in Northern Europe from 1400-1600. Prerequisite: 200-level art history course. Literature Fine Arts Distro Area

**ART_HIST 339-0 Special Topics in Renaissance and Mannerist Art (1 Unit)**
Content varies-for example, the art of Bosch and Brueghel; the history of collecting; art at court; portraiture; gender and representation.
and activism; utopia and dystopia in recent practice; participatory art;

Prerequisite: 200-level art history course.

ART_HIST 369-0 Special Topics in 20th Century Art (1 Unit)
Painting, sculpture, and the graphic arts in Northern Europe from 1600-1700.
Prerequisite: 200-level art history course.

Historical Studies Distro Area Literature Fine Arts Distro Area

ART_HIST 349-0 Special Topics in 19Th Century Art (1 Unit)
Content varies—for example, French art of the 16th and 17th centuries; art and the New World; early modern prints and drawings; art and science.
Prerequisite: 200-level art history course.

ART_HIST 350-1 19th Century Art 1: Late 18th Century-1848 (1 Unit)
Survey of European painting and sculpture. The late 18th century to 1848.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 350-2 19Th Century Art 2: 1848-1900 (1 Unit)
Survey of European painting and sculpture. 1848-1900.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 359-0 Special Topics in Baroque Art (1 Unit)
Content varies—for example, the art of Edouard Manet; orientalism; the spaces of 19th century art; painting in the south of France.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 340-2 Baroque Art: Northern Europe 1600-1700 (1 Unit)
Painting, sculpture, and the graphic arts in Northern Europe from 1600-1700.
Prerequisite: 200-level art history course.

Historical Studies Distro Area Literature Fine Arts Distro Area

ART_HIST 340-2 Baroque Art: Northern Europe 1600-1700 (1 Unit)
Painting, sculpture, and the graphic arts in Northern Europe from 1600-1700.
Prerequisite: 200-level art history course.

Historical Studies Distro Area Literature Fine Arts Distro Area

ART_HIST 359-0 Special Topics in 19Th Century Art (1 Unit)
Content varies—for example, aspects of painting in the Indian

ART_HIST 380-2 Tibetan Buddhist Art 2 (1 Unit)
Focused study of Buddhist art made in Tibet and neighboring countries.
Art of the 15th-19th centuries, including regional developments in eastern and northeastern Tibet.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 380-1 Tibetan Buddhist Art 1 (1 Unit)
Focused study of Buddhist art made in Tibet and neighboring countries.
Art of the Imperial period (7th-9th centuries) through the end of the 14th century, including regional developments in western Tibet.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 382-1 Chinese Painting (1 Unit)
In-depth study of painting in China with consideration of formal and historical developments.
Prerequisite: 200-level art history class.

Literature Fine Arts Distro Area

ART_HIST 384-0 African American Art (1 Unit)
Art of the African-descended cultures of North and South America and the Caribbean.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 380-2 Tibetan Buddhist Art 2 (1 Unit)
Focused study of Buddhist art made in Tibet and neighboring countries.
Art of the 15th-19th centuries, including regional developments in eastern and northeastern Tibet.
Prerequisite: 200-level art history course.

Literature Fine Arts Distro Area

ART_HIST 382-1 Chinese Painting (1 Unit)
In-depth study of painting in China with consideration of formal and historical developments.
Prerequisite: 200-level art history class.

Literature Fine Arts Distro Area

ART_HIST 389-0 Special Topics: Arts of Asia and the Middle East (1 Unit)
Content varies—for example, aspects of painting in the Indian subcontinent: Mughal and Rajput; issues of gender and sexuality in Japan and China from the 18th through 20th century; art in/about the Middle East.
Prerequisite: 200-level art history course.

ART_HIST 401-1 Methods and Historiography of Art History (1 Unit)
1. Introduction to approaches in the discipline of art history; for students in the fall quarter of the first year. 2. Investigation of a philosophical or methodological approach of current interest in art history.

ART_HIST 402-0 Studies in Representation (1 Unit)
ART_HIST 496-0 Internship in the Arts (1 Unit)

Direct participation in the regular activities of an established arts organization in the Evanston/Chicago area under the supervision of a faculty member. By petition to instructor, on a limited basis.

ART_HIST 498-0 Graduate Tutorial (1 Unit)

Supervised studies in the history of art. Content and course requirements vary. Pass/no-credit permitted at the discretion of the graduate advisor.

ART_HIST 499-0 Independent Study (1 Unit)

Permission of instructor and department required. May be repeated for credit.

ART_HIST 570-0 Teaching Assistantship In Art History (1-2 Units)

Directed teaching assistantship in Art History. Students will be graded based upon the quality of their preparation and the success of their teaching. Students may receive a maximum of two course credits for Teaching Assistantships during the period of their enrollment.

ART_HIST 590-0 Research (1-3 Units)

Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**Art Theory & Practice (ART)**

ART 372-0 Seminar (1 Unit)

Variable content, seminar-based course. May be repeated for credit with different topic. Note that some sections of this course are not approved for graduate credit. Please consult the course description.

ART 382-0 Studio/Seminar (1 Unit)

Variable content course with both studio and seminar components. May be repeated for credit with different topic. Note that some sections of this course are not approved for graduate credit. Please consult the course description.

ART 390-0 Studio (1 Unit)

Variable content, studio-based course. May be repeated for credit with different topic. Note that some sections of this course are not approved for graduate credit. Please consult the course description.

ART 422-1 Graduate Critique (1 Unit)

Advanced studio course for MFA candidates.

ART 423-0 Visual Artist's Writing Practicum (1 Unit)

Course explores a wide range of approaches artists use in writing about their work and in using writing as part of their work. Graduate students in departments other than Art Theory and Practice may enroll only with permission of the instructor.

ART 425-0 Graduate Seminar (1 Unit)

Variable content, seminar-based course. May be repeated for credit with different topic. Graduate students in departments other than Art Theory and Practice may enroll only with permission of the instructor.

ART 499-0 Independent Study (1-3 Units)

Course may be repeated, up to a maximum of six credits. Permission of instructor and department required.

**Asian Languages and Cultures (ASIAN_LC)**

ASIAN_LC 492-0 Topical Seminar in Asian Humanities (1 Unit)

Content and prerequisites vary.

ASIAN_LC 499-0 Independent Study (1 Unit)
Astronomy (ASTRON)

ASTRON 405-0 Basics of Radio Astronomy (1 Unit)
Survey of radio astronomy, emphasizing technical aspects; radiation, antennas, receivers, radio spectroscopy, interferometer arrays and aperture synthesis; radio emission mechanisms and cosmic rays.

ASTRON 410-0 Astrophysical Radiative Processes and Transport (1 Unit)

ASTRON 414-0 Planetary Astrophysics (1 Unit)
Planetary Astrophysics Methods of exoplanet detection. The observed architecture of exoplanetary systems. The formation and evolution of planetary systems. Modeling exoplanet interiors and atmospheres. Exoplanet habitability and the search for biosignatures.

ASTRON 416-0 Astrophysical Fluid Dynamics (1 Unit)
Astrophysical Fluid Dynamics. Dynamics of fluids as applied to astrophysical bodies. Topics include hydrostatics, shocks, waves, instabilities, and magnetohydrodynamics. Applications include atmospheres, stars, accretion disks, stellar winds, and galactic disks.

ASTRON 421-0 Observational Astrophysics (1 Unit)
Geometric optics applied to design of optical and x-ray telescopes; diffraction and the Airy disk; radio and optical interferometry and aperture synthesis; adaptive optics; recent developments in detector technology; quantum and thermal noise in astronomy. Independent research projects using the CCD camera and 18-inch refractor in Dearborn Observatory. Offered alternate years. Prerequisite: ASTRON 220-0.

ASTRON 425-0 Stellar Astrophysics (1 Unit)
Physics of stellar interiors, stellar atmospheres, and star formation. Specific topics include simple stellar models, nuclear energy generation, overview of evolutionary phases, white dwarfs, neutron stars, interstellar gas and dust grains, gravitational collapse. Prerequisite: ASTRON 220-0.

ASTRON 429-0 Extragalactic Astrophysics and Cosmology (1 Unit)
Big bang cosmology, Friedman model, thermal history of the Universe, primordial nucleosynthesis, microwave background, dark matter, inflation, large-scale structure, galaxy formation, spiral and elliptical galaxies, and groups and clusters of galaxies.

ASTRON 441-0 Advanced Topics in Astrophysics (1 Unit)
Specialized lectures on current research topics.

ASTRON 443-0 Stellar Structure and Evolution (1 Unit)
Stellar interiors, structure, and atmospheres; thermonuclear reactions, stellar stability, and evolution of binaries. Special topics such as supernovae or brown dwarfs may be included. Prerequisites: ASTRON 425-0 or permission of instructor.

ASTRON 448-0 Interstellar Matter and Star Formation (1 Unit)
Overview of interstellar gas, absorption and emission lines, synchrotron radiation, excitation of atoms and molecules, shocks, supernova remnants, gravitational collapse, and protostars. Prerequisites: ASTRON 425-0 or permission of instructor.

ASTRON 449-0 Stellar Dynamics (1 Unit)
Gravitational potential theory, regular and chaotic orbits, galactic nuclei and supermassive black holes, galactic disk dynamics and spiral structure, evolution of galaxies and star clusters, and dark matter.

ASTRON 450-0 Special Topics in Astronomy (1 Unit)
ASTRON 451-0 High Energy Astrophysics (1 Unit)

ASTRON 499-0 Independent Study (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS May be repeated for credit. Permission of instructor and department required.

ASTRON 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Biological Sciences (BIOL_SCI)

BIOL_SCI 302-0 Fundamentals of Neurobiology (1 Unit)
Cellular and biochemical approaches to the nervous system, focusing on neuron structure and function. May not receive credit for both BIOL_SCI 302-0 and NEUROSCI 202-0. Prerequisites: BIOL_SCI 215-0, BIOL_SCI 219-0, and (BIOL_SCI 301-0 or the former BIOL_SCI 308-0).

BIOL_SCI 305-0 Neurobiology Laboratory (1 Unit)
Hands-on experience in the performance of experiments in cellular neurophysiology. Prerequisites: BIOL_SCI 222-0; BIOL_SCI 302-0 or NEUROSCI 311-0.

BIOL_SCI 315-0 Advanced Cell Biology (1 Unit)
Relationship of shape, structural dynamics, and function with the cellular state and gene expression; cell-to-cell communication. Prerequisites: BIOL_SCI 215-0, BIOL_SCI 219-0, BIOL_SCI 301-0 or the former BIOL_SCI 308-0.

BIOL_SCI 323-0 Bioinformatics: Sequence and Structure Analysis (1 Unit)
Use of informational and modeling techniques to explore evolutionary and other problems related to the genome. Prerequisite: BIOL_SCI 241-0, BIOL_SCI 301-0, or the former BIOL_SCI 308-0.

BIOL_SCI 327-0 Biology of Aging (1 Unit)
Biological aspects of aging, from molecular to evolutionary. Prerequisite: BIOL_SCI 219-0.

BIOL_SCI 341-0 Population Genetics (1 Unit)
Processes that affect allele frequency change and thus cause evolution. Prerequisites: BIOL_SCI 215-0, BIOL_SCI 219-0; a course in statistics.

BIOL_SCI 345-0 Topics in Biology (1 Unit)
Topics vary but always deal with an area of advanced study in the life sciences. With laboratory. May be repeated for credit with different topic. Prerequisites: BIOL_SCI 215-0, BIOL_SCI 219-0, BIOL_SCI 222-0.

BIOL_SCI 346-0 Field Ecology (1 Unit)
An intensive experience in field ecological research. Prerequisites: BIOL_SCI 215-0; a course in statistics.

BIOL_SCI 347-0 Conservation Biology (1 Unit)
Evolution, ecology, and conservation of patterns of biological diversity. Prerequisites: BIOL_SCI 215-0 or ENVR_SCI 202-0; a course in statistics.
Biomedical Engineering (BMD_ENG)

BMD_ENG 314-0 Models in Biochemistry & Molecular Biology (1 Unit)
Mathematical modeling of biochemical and molecular biological problems, such as allosteric enzymes, bacterial transduction, X-ray diffraction, study of DNA.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0; junior standing recommended.

BMD_ENG 315-0 Application of Genetic Engineering to Immunology (1 Unit)
Recent developments in genetic engineering as applied to the rapidly developing field of immunology for antibodies and related proteins.
Prerequisite: junior standing recommended.

BMD_ENG 316-0 Engineering Design of Therapeutic Antibodies (1 Unit)
In-depth study of the development of therapeutic antibodies through protein engineering-the process of selectively modifying the activities of existing proteins and enzymes to improve their function.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0.

BMD_ENG 317-0 Biochemical Sensors (1 Unit)
Theory, design, and applications of chemical sensors used in medical diagnosis and patient monitoring. Electrochemical and optical sensors.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0; CHEM 210-1; PHYSICS 135-2; PHYSICS 135-3.

BMD_ENG 323-0 Visual Engineering Science (1 Unit)
Prerequisite: PHYSICS 135-2.

BMD_ENG 325-0 Introduction to Medical Imaging (1 Unit)
Diagnostic X-rays; X-ray film and radiographic image; computed tomography; ultrasound.
Prerequisite: PHYSICS 135-3 or equivalent.

BMD_ENG 327-0 Magnetic Resonance Imaging (1 Unit)
Nuclear magnetic resonance: two-dimensional Fourier transform, spin echo and gradient echo imaging; gradient and RF hardware.
Prerequisite: PHYSICS 135-3.

BMD_ENG 333-0 Modern Optical Microscopy & Imaging (1 Unit)
Rigorous introduction to principles, current trends, emerging technologies, and biomedical applications of modern optical microscopy.
Prerequisites: PHYSICS 135-2; MATH 220-1; MATH 228-1; GEN_ENG 205-4.

BMD_ENG 343-0 Biomaterials and Medical Devices (1 Unit)
Structure-property relationships for biomaterials. Metal, ceramic, and polymeric implant materials and their implant applications. Interactions of materials with the body. Taught with MAT_SCI 370-0; may not receive credit for both courses.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0; MAT_SCI 201-0 or MAT_SCI 301-0; senior standing.

BMD_ENG 344-0 Biological Performance of Materials (1 Unit)
Structure-property relationships of materials, physical chemistry of surfaces and interfaces, materials-tissue interactions, applications to the selection and design of materials for medical implants and devices.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0; MAT_SCI 201-0.

BMD_ENG 346-0 Tissue Engineering (1 Unit)
In vivo molecular, cellular, and organ engineering, with emphasis on the foundations, techniques, experiments, and clinical applications of tissue engineering.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0.

BMD_ENG 347-0 Foundations of Regenerative Engineering (1 Unit)
Embryonic development, stem cell engineering, somatic regeneration, genome and transcriptome modifications, cell and tissue-level regenerative engineering.
Prerequisite: BIOL_SCI 215-0 or BIOL_SCI 219-0.

BMD_ENG 348-0 Applications of Regenerative Engineering (1 Unit)
Mechanisms of human disease, development and application of molecular, cellular, and tissue-level regenerative engineering strategies to selected human disorders, including neurodegenerative disorders, stroke, cystic fibrosis, cirrhosis, diabetes, muscular degenerative disorders, and skin injury.
Prerequisite: BIOL_SCI 215-0 or BIOL_SCI 219-0.

BMD_ENG 349-1 Regenerative Engineering Principles and Technologies (1 Unit)
Foundations, principles, and technologies of molecular, cellular, and tissue regenerative engineering.
Prerequisites: BIOL_SCI 215-0; BIOL_SCI 219-0.

BMD_ENG 349-2 Regenerative Engineering Applications (1 Unit)
Fundamentals of human disorders; engineering aspects of regenerative medicine; application of regenerative engineering to human disease. Prerequisite: BMD_ENG 349-1.

**BMD_ENG 353-0 Bioelectronics (1 Unit)**
Development and design of sensors, stimulators, and their medical devices for biointegrated electronics. Materials design and fabrication of passive and active components for sensitive, multimodal, and robust wearable and implantable devices.

**BMD_ENG 354-0 Bioelectronics Lab (0.34 Unit)**
Laboratories focused on the practical implementation, instrumentation, and fabrication of wearables and skinsensing. Applications range from vital sign monitoring to rehabilitation.

**BMD_ENG 365-0 Control of Human Limbs and Their Artificial Replacements (1 Unit)**
Human movement, biomechanics, skeletal and muscular anatomy, comparative anatomy, muscle physiology, and locomotion. Engineering design of artificial limbs. Prerequisite: senior standing with engineering or physical science background.

**BMD_ENG 366-0 Biomechanics of Movement (1 Unit)**
Engineering mechanics applied to analyze human movement, including models of muscle and tendon, kinematics of joints, and dynamics of multi-joint movement. Applications in sports, rehabilitation, and orthopedics. Prerequisite: BMD_ENG 271-0.

**BMD_ENG 371-0 Mechanics of Biological Tissue (1 Unit)**
Stress and strain for small and large deformations. Nonlinear elastic, viscoelastic, pseudo-elastic, and biphasic models. Prerequisites: BMD_ENG 271-0; GEN_ENG 205-3; GEN_ENG 205-4.

**BMD_ENG 377-0 Intermediate Fluid Mechanics (1 Unit)**
Fundamental concepts of fluid dynamics. Kinematics, mass and momentum balances, constitutive relations. Navier-Stokes equations and methods of solution. Sealing techniques. Prerequisite: BMD_ENG 270-0 or consent of instructor.

**BMD_ENG 380-0 Medical Devices, Disease & Global Health (1 Unit)**
Health systems and technologies to address health problems of the world's underserved populations, with special emphasis on developing countries.

**BMD_ENG 388-SA Health Systems Engineering (1 Unit)**
Introduction to health systems in the context of disease burden with special emphasis in developing countries. We examine healthcare systems, financing, data and analytics. The course focuses primarily on health-related issues confronting South Africa and the associated social and economic impact. Prerequisite: consent of instructor.

**BMD_ENG 389-SA Health Technology Management (1 Unit)**
This course provides an introduction to formal concepts and methodologies used in support of health technology planning, assessment and adoption - and related decision making - as part of cost-effective healthcare delivery. Open to participants in the Global Health Technologies Program only.

**BMD_ENG 390-3 Biomedical Engineering Design (1 Unit)**
Continuation of a design project; independent study. May not be repeated for credit. Prerequisites: BMD_ENG 390-1 or BMD_ENG 390-2; consent of instructor.

**BMD_ENG 391-SA HealthCare Technology Innovation and Design (1 Unit)**
Principles and practice of medical device design for the developing world. Evaluation of user needs in the environment of under-resourced segments of South African health care system. Validation and verification of engineering design solutions. Open to participants in the Global Health Technologies Program only.

**BMD_ENG 395-0 Topics in Biomedical Engineering (1 Unit)**
Special Topics in Biomedical Engineering.

**BMD_ENG 396-0 Special Topics (0.5 Unit)**
Special Topics in Biomedical Engineering. Laboratory emphasis.

**BMD_ENG 398-0 Special Topics in Biomedical Engineering (0.34 Unit)**
Special Topics in Biomedical Engineering. Laboratory emphasis.

**BMD_ENG 401-0 Advanced Systems Physiology (1 Unit)**
Physiology of the central and peripheral nervous systems. Biophysics of the nerve cell from an engineering perspective. General overview and in-depth study of original work.

**BMD_ENG 402-0 Advanced Systems Physiology (1 Unit)**
Physiology of the heart, circulatory system, lungs, and respiration from an engineering perspective. General overview and in-depth study of original work.

**BMD_ENG 403-0 Advanced Systems Physiology (1 Unit)**
Physiology of the renal, digestive, and endocrine systems. Membrane transport, epithelia, and second messenger systems from an engineering perspective. General overview and in-depth study of original work.

**BMD_ENG 407-0 Experimental Design and Measurement (1 Unit)**
Introductory quantitative skills required to conduct experimental research and analyze resulting data. Principles of measurement, modeling of experimental data, and statistical design of experiments.

**BMD_ENG 425-0 fMRI (Functional Imaging) (1 Unit)**
Cutting-edge functional imaging techniques and their applications in research and clinical practice. MRI is the predominantly discussed modality but also includes other modalities.

**BMD_ENG 427-0 Advanced MR Imaging (1 Unit)**
The use and design of MR pulse sequences; emphasis on image contrast mechanisms and some of the more widely used MR acquisition strategies. Prerequisite: BMD_ENG 327-0

**BMD_ENG 429-0 Advanced Physical and Applied Optics (1 Unit)**
Theory and applications of the state-of-the-art physical optics. Topics include wave optics, Gaussian optics, Fourier optics, light propagation in continuous and turbid media, light scattering, statistical optics, and fiber optics.

**BMD_ENG 444-0 Organic Nanomaterials (1 Unit)**
The materials science and chemistry of soft nanomaterials for myriad applications including nanomedicine. Preparative and synthetic approaches to organized, assembled, discrete nanomaterials will be described. Course will include an in depth discussion of advanced characterization techniques and strategies for this class of material.

**BMD_ENG 445-0 Principles of Immunoeengineering (1 Unit)**
This course covers therapeutically relevant recent advancements in immunology and resulting applications in the field of immunoeengineering. Biomaterials and in particular nanomaterials are presented as a tool for modifying immune responses. Applications for cancer immunotherapy, vaccine development and the treatment of autoimmune disorders will be discussed.

**BMD_ENG 446-0 Biomaterials in Synthetic Biology (1 Unit)**
A course that focuses on the emerging principles in synthetic biology that have the capability to expand the functionality of biomaterials: what properties of biomaterials 'matter', emerging techniques to control the
biological-material interface, and ways of inscribing the vital functions found in biological systems into synthetic materials.

**BMD_ENG 447-0 Drug Delivery (1 Unit)**
The class familiarizes students with transport of drugs in engineered drug delivery systems and through biological tissues and then applies these concepts to real world drug delivery systems.

**BMD_ENG 448-0 Cardiovascular Protective Engineering (1 Unit)**
Natural protective mechanisms developed through evolution, protective engineering strategies against cardiovascular injuries and disorders, including atherosclerosis, arterial aneurysms, heart attack, cardiomyopathies, heart failure, and congenital disorders.

**BMD_ENG 452-0 Transport Through Connective Tissue (1 Unit)**
Use of porous media theory to examine principles governing fluid flow and mass transfer in extracellular matrices and the application of these principles to tissue engineering.

**BMD_ENG 461-0 Neural Engineering: Computational Neuromechanics and Neuroethology (1 Unit)**
The brain and the body work together closely in adaptive behavior. Using a well-characterized system as our base, this coupling is examined quantitatively.

**BMD_ENG 462-0 Neural Engineering: Sensory Acquisition through Movement (1 Unit)**
The class involves a neuroethological approach to the nervous system, comparing how information is encoded and processed across sensory modalities, and examining the relation between sensing and movement.

**BMD_ENG 463-0 Neuropathophysiology (1 Unit)**
A quantitative approach to the study and treatment of neurological diseases, including stroke, SCI and visual deficits. Incorporates neuropathophysiology, computer modeling and systems analysis.

**BMD_ENG 465-0 Biomechanical Modeling & Simulation of Human Movement (1 Unit)**
This course is designed to familiarize the student with the development and use of biomechanical models to simulate motion.

**BMD_ENG 467-0 Biomedical Robotics (1 Unit)**
A perspective on robotics technologies applied to, and inspired by, themes of biomedical research and practice.

**BMD_ENG 469-0 Neural Control and Mechanics of Movement (1 Unit)**
Muscle mechanics and relevant spinal cord neurophysiology as the basis for understanding neural control of movement.

**BMD_ENG 475-0 Cardiovascular Biology & Engineering (1 Unit)**
Molecular basis of cardiovascular development, performance, and pathogenesis; engineering analysis of cardiovascular functions; and fundamentals of cardiovascular engineering and regeneration.

**BMD_ENG 478-0 Transport Fundamentals (1 Unit)**
Fundamental and biomedical applications of diffusive and convective heat and mass transfer with problems appropriate for graduate students.

**BMD_ENG 495-0 Special Advanced Topics in Biomedical Engineering (1 Unit)**
Current topics of interest for graduate students. May be repeated for credit with change of topic.

**BMD_ENG 499-0 Projects (1-3 Units)**
Permission of instructor and department required. May be repeated for credit.

**BMD_ENG 512-0 Graduate Research Seminar in Biomedical Engineering (0 Unit)**
A series of seminars covering current research interests in biomedical engineering. Attendance by first-year Biomedical Engineering graduate students required.

**BMD_ENG 590-0 Research (1-4 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

## Career Development (CRDV)

**CRDV 410-1 Cooperative Engineering Education (0 Unit)**

**CRDV 410-2 Cooperative Engineering Education (0 Unit)**

**CRDV 410-3 Cooperative Engineering Education (0 Unit)**

**CRDV 410-4 Cooperative Engineering Education (0 Unit)**

**CRDV 411-1 Professional Engineering Internship (0 Unit)**

**CRDV 411-2 Professional Engineering Internship (0 Unit)**

**CRDV 411-3 Professional Engineering Internship (0 Unit)**

**CRDV 412-1 Graduate Engineering Projects in Service Learning (0 Unit)**

**CRDV 412-2 Graduate Engineering Projects in Service Learning (0 Unit)**

**CRDV 412-3 Graduate Engineering Projects in Service Learning (0 Unit)**

**CRDV 414-1 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CRDV 414-2 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CRDV 414-3 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CRDV 414-4 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CRDV 414-5 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required
to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CRDV 414-6 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CRDV 414-7 Career Development for Student Entrepreneurs (0 Unit)**
An opportunity for McCormick students who have created and/or manage start-up companies in the Chicagoland area to receive mentorship and training in the areas of business development, principles of supervision, leadership development and product development. Students are required to work directly with an entrepreneurial advisor of their choice including: entrepreneurship faculty, senior business executives, and other seasoned entrepreneurs.

**CHEM_ENG 510-0 Crown Family Graduate Internship (0 Unit)**

### Chemical Engineering (CHEM_ENG)

**CHEM_ENG 307-0 Kinetics and Reactor Engineering (1 Unit)**
Chemical reaction kinetics with application to the design of chemical reactors.
Prerequisites: CHEM_ENG 210-0, CHEM_ENG 211-0, CHEM_ENG 321-0, CHEM_ENG 322-0.

**CHEM_ENG 312-0 Probability and Statistics for Chemical Engineering (1 Unit)**
Introduction to probability theory and statistical methods necessary for analyzing the behavior of processes and experiments. Statistical tests for detecting significant changes in process parameters.
Prerequisites: MATH 220-1, MATH 220-2, MATH 228-1, & MATH 228-2 (formerly listed as MATH 220-0, MATH 224-0, MATH 230-0, & MATH 234-0), or ES_APPM 252-1 & ES_APPM 252-2.

**CHEM_ENG 321-0 Fluid Mechanics (1 Unit)**
Derivation and applications of continuity and Navier-Stokes equations. Macroscopic mass, momentum, and energy balance. Dimensional analysis: friction factors in pipes and packed beds; drag coefficients.
Prerequisites: completion of mathematics requirements with no grades of D; GEN_ENG 205-4 (C- or better).

**CHEM_ENG 322-0 Heat Transfer (1 Unit)**
The differential equations of energy transport. Solutions for various applications.
Prerequisites: completion of mathematics requirements with no grades of D; GEN_ENG 205-4 (C- or better); CHEM_ENG 321-0 recommended.

**CHEM_ENG 323-0 Mass Transfer (1 Unit)**
Diffusion and rate concepts; application to distillation, extraction, absorption, humidification, drying.
Prerequisites: CHEM_ENG 321-0, CHEM_ENG 322-0.

**CHEM_ENG 330-0 Molecular Engineering and Statistical Mechanics (1 Unit)**
Basic statistical mechanics. Applications to thermodynamics, kinetics, and transport of various engineering systems, including frontier areas of chemical and biological engineering. Not open to students who have taken CHEM_ENG 406-0, CHEM 342-3, or PHYSICS 332-0.

Prerequisite: CHEM_ENG 211-0 or another thermodynamics course; courses in probability and statistics, heat transfer, or other transport recommended.

**CHEM_ENG 341-0 Dynamics and Control of Chemical and Biological Processes (1 Unit)**
Dynamic behavior of chemical process components. Feedback control principles.
Prerequisites: CHEM_ENG 307-0; senior standing.

**CHEM_ENG 342-0 Chemical Engineering Laboratory (1 Unit)**
Operation and control of process equipment for the determination of operating data. Analysis and written presentation of results.
Prerequisites: CHEM_ENG 212-0, CHEM_ENG 307-0, CHEM_ENG 321-0, CHEM_ENG 322-0, CHEM_ENG 323-0.

**CHEM_ENG 345-0 Process Optimization for Energy and Sustainability (1 Unit)**
Modern techniques and application to the design and operation of chemical process systems. Steady-state and dynamic methods. Experimental search for the optimum.
Prerequisite: junior standing.

**CHEM_ENG 351-0 Process Economics, Design, & Evaluation (1 Unit)**
Preliminary design of industrial processes for the production of chemical and allied products by the application of the engineering sciences and economics.
Prerequisites: CHEM_ENG 212-0, CHEM_ENG 307-0, CHEM_ENG 321-0, CHEM_ENG 322-0, CHEM_ENG 323-0.

**CHEM_ENG 352-0 Chemical Engineering Design Projects (1 Unit)**
Design of chemical and process plants applying the principles of unit operations, thermodynamics, reaction kinetics, and economics. Mechanical design and selection of chemical process equipment.
Prerequisite: CHEM_ENG 351-0.

**CHEM_ENG 355-0 Chemical Engineering Product Design (1 Unit)**
Properties and selection of chemicals for products from single-molecule pharmaceuticals to devices to manufactured products such as food and consumer goods.
Prerequisite: junior standing.

**CHEM_ENG 360-0 Introduction to Polymers (1 Unit)**
Polymerization mechanisms and their relation to molecular structure, polymerization processes, and the mechanical properties of polymers, especially flow behavior.
Prerequisites: CHEM_ENG 211-0 or other thermodynamics course; CHEM 210-1.

**CHEM_ENG 364-0 Chemical Processing and the Environment (1 Unit)**
Application of chemical engineering fundamentals to environmental problems. Chemistry and mechanisms, chemical reaction and rate, and transport emphasized. Risk assessment and analysis revealed through case studies.
Prerequisites: CHEM_ENG 212-0, CHEM_ENG 307-0.

**CHEM_ENG 365-0 Sustainability, Technology, and Society (1 Unit)**
Technical discussion of selected topics related to sustainability, sustainable development, global climate changes, natural and renewable resources and utilization, industrial ecology, eco-efficiency, technology related to sustainability such as biofuel, electrification of transportation, and water purification, and role of policy and business risk assessment.
Prerequisites: junior standing in science or engineering; familiarity with process system analysis, energy and material balances (such as found in CHEM_ENG 210-0 or CIV_ENV 260-0).

**CHEM_ENG 367-0 Quantitative Methods in Life Cycle Analysis (1 Unit)**
Lifecycle analysis (LCA) framework for environmental assessment of technology systems, focusing on modeling methods for systems mass and energy flows, process and input-output-based systems inventories, environmental impact analysis, and methods for robust engineering decisions. MECH_ENG 367-0 is taught with CHEM_ENG 367-0; may not receive credit for both courses.

CHEM_ENG 372-0 Bionanotechnology (1 Unit)
Physical biology of the cell and its implications for nanotechnology, with a focus on the quantitative description of sizes, shapes, times, and energies at the nanoscale.
Prerequisite: MATH 228-1 (formerly listed as MATH 230-0).

CHEM_ENG 373-0 Biotechnology and Global Health (1 Unit)
Recent advances in synthetic biology and genetic, metabolic, and tissue engineering. Design, development, and commercialization of healthcare technologies for countries in the developing world and the challenges of deploying preventative, diagnostic, and therapeutic products in these settings.

CHEM_ENG 375-0 Biochemical Engineering (1 Unit)
Prerequisite: CHEM_ENG 307-0, CHEM_ENG 323-0, or consent of instructor.

CHEM_ENG 376-0 Principles of Synthetic Biology (1 Unit)
Overview of synthetic biology’s foundations in the natural sciences and engineering and its applications in medicine, biotechnology, and green chemistry. How engineering driven approaches may be used to accelerate design-build-test loops required for reprogramming existing biological systems and constructing new ones.
Prerequisite: CHEM_ENG 275-0 or BIOL_SCI 215-0 or BIOL_SCI 219-0.

CHEM_ENG 377-0 Bioseparations (1 Unit)
Downstream process in biotechnology. Separation and lysis of cells.
Recovery of organelles and proteins. Protein separation and purification.
Prerequisites: CHEM_ENG 323-0 (may be taken concurrently); CHEM_ENG 275-0 or BIOL_SCI 215-0 or BIOL_SCI 219-0.

CHEM_ENG 379-0 Computational Biology: Principles & Applications (1 Unit)
Introduction to the development and application of data-analytical and theoretical methods, mathematical modeling, and computational simulation techniques to the study of biological systems.

CHEM_ENG 381-0 Practical Biological Imaging (1 Unit)
Theory and practice of biological microscopy in a lab setting; image acquisition, analysis, and the ethics of image manipulation.

CHEM_ENG 382-0 Regulatory Sciences in Biotechnology (1 Unit)
Course on topics at the intersection of science, engineering, and biotech regulatory compliance. Federal regulations for drug product development; regulatory compliance processes and organizational structure; interface between biotechnology processes and regulatory sciences; global harmonization of regulations; regulatory documentation.

CHEM_ENG 395-0 Special Topics in Chemical Engineering (1 Unit)
Topics suggested by students or faculty and approved by the department.

CHEM_ENG 404-0 Advanced Thermodynamics (1 Unit)
Quantitative study of the fundamental principles of thermodynamics. Application of the laws of thermodynamics, concepts of equilibrium, equations of state, and properties of solutions to problems of engineering significance, including phase and chemical reaction equilibria.

CHEM_ENG 406-0 Selected Topics in Thermodynamics (1 Unit)
Selected topics from recent literature in thermodynamics.

CHEM_ENG 408-0 Chemical Engineering Kinetics and Reactor Design (1 Unit)
Interpretation of chemical rate selectivity data in homogeneous and heterogeneous reaction systems. Development and application of the theory of chemical kinetics, including collision, transition state, and surface reactivity approaches. Theory and analysis of reaction in heterogeneous phases. Reactor design with applications to and extension of ideal and nonideal reactor models: gas-solid, gas-liquid, and three-phase reactor design.

CHEM_ENG 409-0 Advanced Reactor Design (1 Unit)
Advanced engineering aspects of reactor design. Analysis of coupled transport processes and chemical reaction in application to realistic design and scale-up of various types of chemical reactors. Optimization problems in reactor design and operation.

CHEM_ENG 410-0 Principles of Heterogeneous Catalysis (1 Unit)
Recent publications in heterogeneous catalysis are reviewed along with formal lectures on fundamentals. Topics include kinetics and mechanisms of surface reactions, catalyst characterization, structure of solids, surface reactivity trends, active site concepts, importance of mass transfer, and examples of catalysis by metals, oxides, sulfides and zeolites.

CHEM_ENG 421-0 Fluid Mechanics (1 Unit)
Derivation of Navier-Stokes equations and their application for solution of fluid mechanics problems in the inviscid fluid, creeping flow and boundary layer approximations.

CHEM_ENG 422-0 Heat and Mass Transfer (1 Unit)
Heat and Mass transfer by heat conduction, diffusion, and convection. (Linear phenomena only; heat transfer by radiation, natural convection, and mass transfer in concentrated solutions are not discussed.) Steady-state and transient processes. General formulation, approximations, and model building. Emphasis on developing physical insight.

CHEM_ENG 451-0 Applied Molecular Modeling (1 Unit)
Introduction to modern computational methods for calculating properties of reaction systems, as well as thermodynamics, transport, and structural properties of materials.

CHEM_ENG 462-0 Viscoelasticity & Flow in Polymer Systems (1 Unit)
Fundamental aspects of polymer rheology, including the theory of linear viscoelasticity, measurement of fundamental flow properties, constitutive equations, the kinetic- molecular theories of viscoelasticity, and polymer processing behavior.

CHEM_ENG 463-0 Polymerization Reaction Engineering (1 Unit)
Polymization reactions and resulting molecular weight distributions; modeling of polymerization kinetics; batch, continuous stirred tank and tubular flow reactor design for optimal polymerizations; emulsion and catalyzed polymerizations; photoresist technology.

CHEM_ENG 472-0 Interfacial Phenomena and Bipolymer Technology (1 Unit)
Downstream processing in biotechnology. Separation and lysis of cells.
Recovery of organelles and proteins. Protein separation and purification.
Prerequisites: CHEM_ENG 321-0, CHEM_ENG 323-0 (or equivalent), CHEM_ENG 375-0.

CHEM_ENG 478-0 Advances in Biotechnology (1 Unit)
The emergence of new tools and ideas in biotechnology continues to accelerate, and this course is an introduction to a range of topics at the forefront of this field. The objective of this class is to expose students to the multidisciplinary research, and provide technical and intellectual skills from fields such as biochemical engineering, biochemistry,
bioengineering, biomaterials, metabolic engineering, molecular biology, nanobiotechnology, pharmacology, and tissue engineering.

**CHEM_ENG 489-0 Selected Topics in Chemical Engineering (1 Unit)**
Selected topics from recent literature.

**CHEM_ENG 499-0 Projects (1-3 Units)**
Thorough study and submission of a report on a chemical engineering problem. Permission of instructor and department required. May be repeated for credit.

**CHEM_ENG 510-0 Seminar (0 Unit)**
Department seminar.

**CHEM_ENG 520-0 Professional Development in Research in Chemical and Biological Engineering (0 Unit)**
A required class for all PhD students in Chemical and Biological Engineering. This class will cover necessary skills and best practices for research, including expectation and intensity, developing and maintaining a network, running an effective meeting, effective correspondence, interfacing with collaborators, effective oral and written scientific communication, data management, and digging into the research literature.

**CHEM_ENG 590-0 Research (1-4 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**Chemistry (CHEM)**

**CHEM 360-0 Nanopatterning: Top-down meets Bottom-up (1 Unit)**
Introduction to current problems in nanoscale science and technology; hands-on experience with nanoscale characterization tools and benchtop nanoscale experiments. With laboratory.
Prerequisites: CHEM 132-0 and CHEM 142-0, or CHEM 152-0 and CHEM 162-0, or CHEM 172-0 and CHEM 182-0 (C- or better), or equivalent. *Natural Sciences Distro Area*

**CHEM 401-0 Principles of Organic Chemistry (1 Unit)**
Introduction to the field of physical organic chemistry. Topics include bonding and structure, conformational analysis, stereochemistry, acids and bases, reactivity, and reaction mechanisms. CHEM 301-0 and CHEM 401-0 are taught together.
Prerequisites: CHEM 212-3 or CHEM 210-3 and CHEM 230-3 (C- or better) and 1 quarter of physical chemistry; or consent of instructor.

**CHEM 402-0 Principles of Inorganic Chemistry (1 Unit)**
Topics in advanced inorganic chemistry. CHEM 302-0 and CHEM 402-0 are taught together.
Prerequisite: CHEM 333-0 or consent of instructor.

**CHEM 403-0 Principles of Physical Chemistry (1 Unit)**
An overview of advanced topics in physical chemistry. CHEM 303-0 and CHEM 403-0 are taught together.
Prerequisites: CHEM 342-1 and CHEM 342-2 and CHEM 342-3.

**CHEM 405-0 Chemistry of Life Processes (1 Unit)**
Topics in the chemistry and biochemistry of life processes. Taught with CHEM 305-0.
Prerequisites: CHEM 210-3 and CHEM 230-2 or CHEM 212-3 and 1 biochemistry course; or consent of instructor.

**CHEM 406-0 Environmental Chemistry (1 Unit)**
Topics in the physical chemistry of the environment. Taught with CHEM 306-0.
Prerequisites: CHEM 210-3 and CHEM 230-3 or CHEM 212-3 (C- or better); MATH 234-0, MATH 250-0; PHYSICS 135-1 and PHYSICS 135-2; or consent of instructor.

**CHEM 407-0 Materials and Nanochemistry (1 Unit)**
Introduction to frontier research at the interface of chemistry and materials science. CHEM 307-0 and CHEM 407-0 are taught together.
Prerequisites: CHEM 212-3 or CHEM 210-3 and CHEM 230-3 (C- or better).

**CHEM 408-0 Design, Synthesis, and Applications of Nanomaterials (1 Unit)**
Approaches to the fabrication, chemical synthesis, assembly and characterization of controlled dimensionality materials including metals, semiconductors, oxides, polymers, and mesoporous scaffolds. Topics include interfacial phenomena and particle stability, nanoforms of carbon, and applications-driven material design. Taught with CHEM 308-0.

**CHEM 409-0 Polymer Chemistry (1 Unit)**
This course will cover the design and synthesis of polymers, including reaction mechanisms, characterization, and structure-property relationships. CHEM 309-0 is taught with CHEM 409-0. Prerequisites (for undergraduates only): a full year of undergraduate organic chemistry (CHEM 210-1, CHEM 210-2, and CHEM 210-3 OR CHEM 212-1, CHEM 212-2, and CHEM 212-3), and one of the following courses: CHEM 307-0/ CHEM 407-0, CHEM 313-0/ CHEM 413-0, CHEM 319-0/ CHEM 419-0, CHEM 412-0, or CHEM 415-0.

**CHEM 410-0 Physical Organic Chemistry (1 Unit)**
Methods in the investigation of reaction mechanisms. Stereochemistry, conformational analysis, thermochemistry, kinetics, isotope effects, solvent effects, quantitative structure-reactivity relationships, pericyclic reactions, and photochemistry.

**CHEM 411-0 Organic Spectroscopy (1 Unit)**
Applications of contemporary spectroscopic methods to organic structural and dynamic problems.

**CHEM 412-0 Organometallic Reaction Mechanisms (1 Unit)**
Organic reaction mechanisms, including carbocations, carbanions, carbenes, nitrenes, radicals, rearrangement reactions and photochemistry.

**CHEM 413-0 Advanced Organic Chemistry 1. Advanced concepts of organic reactivity and selectivity in synthesis. (1 Unit)**
Advanced topics in organic chemistry: bonding, reaction intermediates, functional group transformations, reaction methodology; approaches to natural product synthesis.

**CHEM 413-2 Advanced Organic Chemistry II (1 Unit)**
Advanced topics in organic chemistry continued: organometallic reaction methodology, catalysis, and their application to total synthesis.

**CHEM 414-0 Advanced Organic Chemistry (1 Unit)**
Topics vary. Recent topics include carbanions, catalysis of organic reactions, enzyme mechanisms, natural products, nucleotide chemistry, and photochemistry.

**CHEM 415-0 Advanced Organic Chemistry (1 Unit)**
Topics vary. Recent topics include carbanions, catalysis of organic reactions, enzyme mechanisms, natural products, nucleotide chemistry, and photochemistry.

**CHEM 416-0 Practical Training in Chemical Biology Methods and Experimental Design (1 Unit)**
Experimental design, data analysis, mass spectrometry; proteomics, in vivo and molecular imaging, small molecule synthesis and purification; high-throughput screening, x-ray crystallography, analysis of bioelements.

**CHEM 417-0 Photochemistry (1 Unit)**
The physical and chemical behavior of electronically excited molecules. Methods for the investigation of excited state phenomena and major classes of photochemical reactions.

**CHEM 418-0 Organometallic Chemistry and Homogeneous Catalysis (1 Unit)**
The basic reactions of organometallic chemistry and their applications in homogeneous catalysis.

**CHEM 419-0 Advanced Organic Synthesis - Concepts and Applications (1 Unit)**


Prerequisites: CHEM 210-3 and CHEM 230-3 or CHEM 212-3 (C- or better).

**CHEM 432-0 X-Ray Crystallography (1 Unit)**

This class focuses on structure determination by X-Ray Crystallography. The course includes lectures on crystallographic theory and practice as well as hands-on experience with instrumentation and structure determination software.

**CHEM 433-0 Structural Inorganic Chemistry (1 Unit)**

Chemical applications of group theory and the determination of molecular structure by modern physical techniques.

**CHEM 434-0 Inorganic Chemistry (1 Unit)**

Inorganic and solid-state chemistry of main group elements, particularly those in Group III, second and third transition elements, lanthanides, and actinides.

**CHEM 435-0 Advanced Inorganic Chemistry (1 Unit)**

Topics vary. Recent topics include organometallic chemistry, coordination chemistry, hydride chemistry, ligand field theory, solid-state chemistry, and photoelectron spectroscopy of inorganic compounds.

**CHEM 435-1 Advanced Inorganic Chemistry (1 Unit)**

Topics vary. Recent topics include organometallic chemistry, coordination chemistry, hydride chemistry, ligand field theory, solid-state chemistry, and photoelectron spectroscopy of inorganic compounds.

**CHEM 442-1 Quantum Chemistry (1 Unit)**

First Quarter: Principles of basic quantum mechanics, approximation methods, applications to molecules, and introductory group theory. Second Quarter: Molecular orbital theory, applications of group theory, and quantum mechanics as applied to spectroscopy.

**CHEM 442-2 Quantum Chemistry (1 Unit)**

First Quarter: Principles of basic quantum mechanics, approximation methods, applications to molecules, and introductory group theory. Second Quarter: Molecular orbital theory, applications of group theory, and quantum mechanics as applied to spectroscopy.

**CHEM 443-0 Kinetics (1 Unit)**

Rates and mechanisms of reactions; modern developments in chemical kinetics. Scattering theory, transition state theory, unimolecular reactions, reactions in solution, reactivity as a function of internal energy of reactants, molecular beam kinetics, and enzyme kinetics.

**CHEM 444-0 Elementary Statistical Mechanics (1 Unit)**

Statistical mechanics in chemical systems. Partition functions, thermodynamic correspondence, absolute rate theory, equilibrium, vibration behavior of solids, and adsorption theory.

**CHEM 445-0 Advanced Physical & Analytical Chemistry (1 Unit)**

Topics vary. Recent topics include electrochemistry, molecular beam kinetics, electron spectroscopy, molecular reaction dynamics, laser spectroscopy, separations, and resonance spectroscopy.

**CHEM 448-0 Computational Chemistry (1 Unit)**

The theory and application of molecular electronic structure methods, techniques for determining vibrational eigenfunctions and scattering properties, and molecular mechanics, molecular mechanics and Monte Carlo calculations. Included are extensive applications to chemical problems using Unix workstations.

**CHEM 460-0 Seminar in Organic Chemistry (0 Unit)**

Current research topics presented by visiting Northwestern University speakers.

**CHEM 461-0 Seminar in Physical Chemistry (0 Unit)**

Current research topics presented by visiting Northwestern University speakers.

**CHEM 463-0 Seminar in Inorganic Chemistry (0 Unit)**

Current research topics presented by visiting Northwestern University speakers.

**CHEM 498-0 Organic Chemistry Independent Study (1 Unit)**

Advanced work for students through supervised reading, research, and discussion.

Prerequisite: consent of department.

**CHEM 499-0 Independent Study (1 Unit)**

May be repeated for credit. Permission of instructor and department required.

**CHEM 519-0 Responsible Conduct of Research Training (0 Unit)**

This seminar examines topics including theories of citizenship, the scope of civic action and public work, the nature of public scholarship, and the role of public intellectuals in civic life. Students will undertake an internship or field study in a community organization, educational setting, or non-profit.

**CHEM 570-0 Chemistry Colloquium (1 Unit)**

N/A.

**CHEM 571-0 Research Seminar in Biological Chemistry (1 Unit)**

N/A.

**CHEM 573-0 Research Seminar in Chemical Physics & Theoretical Chemistry (1 Unit)**

N/A.

**CHEM 575-0 Research Seminar in Organometallic & Coordination Chemistry (1 Unit)**

N/A.

**CHEM 576-0 Research Seminar in Physical Organic Chm (1 Unit)**

N/A.

**CHEM 577-0 Research Seminar in Solid State Chem (1 Unit)**

N/A.

**CHEM 578-0 Research Seminar in Synthetic Organic (1 Unit)**

N/A.

**CHEM 590-0 Research (1-4 Units)**

Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**Chicago Field Studies (CFS)**

**CFS 495-0 Civic Engagement and Graduate Education (1-3 Units)**

This seminar examines topics including theories of citizenship, the scope of civic action and public work, the nature of public scholarship, and the role of public intellectuals in civic life. Students will undertake an internship or field study in a community organization, educational setting, or non-profit.

**Chicago Metropolitan Exchange Program (CME)**

**CME 585-0 Chicago Metropolitan Exchange (1 Unit)**
Chinese (CHINESE)

CHINESE 410-0 Advanced Study (1 Unit)

CIC Traveling Scholar (CIC)

CIC 585-8 CIC Traveling Scholar (1 Unit)

Civil and Environmental Engineering (CIV_ENV)

CIV_ENV 302-0 Engineering Law (1 Unit)
The American legal system from an engineer’s perspective. Socratic-
method analysis of statutory and case law. Contract, patent, corporation,
antitrust, property, and environmental law. Torts, product liability, and
arbitration.
Prerequisite: junior engineering standing.

CIV_ENV 303-0 Environmental Law and Policy (1 Unit)
An introduction to important aspects of environmental law and policy.
Covers a wide range of environmental topics, with a focus on major
federal environmental statutes.
Prerequisite: junior or senior standing.

CIV_ENV 304-0 Civil and Environmental Engineering Systems Analysis (1 Unit)
Quantitative techniques to develop descriptive and prescriptive
models that support efficient planning and management of civil and
environmental engineering systems.
Prerequisite: MATH 220-2 or equivalent.

CIV_ENV 306-0 Uncertainty Analysis (1 Unit)
Probability, statistics, and decision theory. Discrete and continuous
random variables, marginal and conditional distributions, moments,
statistical model selection and significance tests, hypothesis testing,
and elementary Bayesian decision theory. Application to problems in soil
mechanics, water resources, transportation, and structures.

CIV_ENV 314-0 Organic Geochemistry (1 Unit)
The sources and fates of organic matter in the natural environment;
global cycling of organic carbon; applications to the study of modern and
ancient environments. Taught with EARTH 314-0; may not receive credit
for both courses.
Prerequisites: 1 course in earth and planetary sciences or environmental
sciences; 1 course in chemistry.

CIV_ENV 317-0 Biogeochemistry (1 Unit)
Cycling of biogenic elements (C, N, S, Fe, Mn) in surficial environments.
Emphasis on microbial processes and isotopic signatures.
Prerequisites: 1 quarter of chemistry; 1 quarter of geoscience,
environmental sciences, or biological sciences.

CIV_ENV 318-0 Mechanics of Fracture (1 Unit)
Stress concentration, analysis of the stress field near a crack tip, fracture
modes, brittle and ductile fracture, fracture toughness, fracture criteria,
fracture mechanics design, fatigue, and dynamic effects.

CIV_ENV 319-0 Theory of Structures 2 (1 Unit)
Shear center, non-prismatic members, nonlinear materials, influence
lines, Mueller-Breslaup principle, approximate methods of analysis, energy
methods, stiffness matrix, and computer methods of analysis.
Prerequisite: CIV_ENV 221-0.

CIV_ENV 320-0 Structural Analysis--Dynamics (1 Unit)
Single and multiple degree-of-freedom systems subjected to periodic,
seismic, and general loadings. Time-history analysis of linear and
nonlinear systems. Design methods for earthquakes.
Prerequisite: CIV_ENV 221-0.

CIV_ENV 321-0 Concrete Properties (1 Unit)
Concrete as a composite material; relationship between constitutive laws
and microstructure; failure theories; fracture; fatigue; strain rate effects;
destructive and nondestructive testing; creep and shrinkage; chemistry of
cement hydration; admixtures; aggregates; proportioning; new materials.

CIV_ENV 322-0 Structural Design (1 Unit)
Design criteria; planning and design aspects of structural systems for
gravity and lateral loads. A total design project involving the analysis and
design of a structure.
Prerequisite: CIV_ENV 325-0 or equivalent.

CIV_ENV 323-0 Structural Steel Design (1 Unit)
Rational basis of structural design. Design approach for structural-steel
components of a building system.
Prerequisites: CIV_ENV 216-0; CIV_ENV 221-0 or equivalent.

CIV_ENV 325-0 Reinforced Concrete (1 Unit)
Fundamentals of reinforced concrete theory and design. Analysis and
design of beams, slabs, and columns. Concurrent familiarization with
current building codes, specifications, and practices.
Prerequisite: CIV_ENV 221-0.

CIV_ENV 327-0 Finite Element Methods in Mechanics (1 Unit)
Development of finite elements from variational principles and
application to static stress analysis. Introduction to techniques for
transient and generalized field problems. Computer implementation of
finite element techniques. Taught with MECH_ENG 327-0; may not receive
credit for both courses.

CIV_ENV 330-0 Engineering Project Management (1 Unit)
Techniques for coordinating decisions and actions of various parties
in the design and construction of civil and environmental engineering
projects. Delivery systems; preconstruction services; project planning;
cost control and value engineering; bidding.
Prerequisite: instructor consent.

CIV_ENV 332-0 Building Construction Estimating (1 Unit)
Estimation of cost at different stages of design; conceptual estimating
and quantity takeoff of various elements, such as materials, labor, and
equipment.
Prerequisites: CIV_ENV 330-0; consent of instructor.

CIV_ENV 336-0 Project Scheduling (1 Unit)
Project planning, scheduling, and control using CPM arrow and
precedence networks; resource allocation and resource leveling; earned
value analysis; linear scheduling; PERT, CPM in dispute resolution and
litigation, computer scheduling.
Prerequisite: CIV_ENV 330-0.

CIV_ENV 340-0 Hydraulics and Hydrology (1 Unit)
Civil and environmental engineering applications of fluid mechanics.
Turbulent flow in pipes and rivers, pipe and river networks, and open
channels.
Prerequisite: MECH_ENG 241-0.

CIV_ENV 346-0 Ecosystems (1 Unit)
Interactions between water and ecosystems in freshwater, terrestrial, and
urban environments. Feedbacks between ecological and hydrological
processes. Engineering of ecosystems such as constructed wetlands,
green roofs, and other green infrastructure for resilient and sustainable
water management.

CIV_ENV 349-0 Environmental Management (1 Unit)
CIV_ENV 368-0 Sustainability: The City (1 Unit)
The roles and responsibilities of project managers who deal with environmental issues. How managers deal with previously created environmental problems, respond to current requirements, and anticipate future needs.
Prerequisites: a technical background and senior standing.

CIV_ENV 352-0 Foundation Engineering (1 Unit)
Application of soil mechanics to analysis and design of foundations and embankments. Settlement of structures, bearing capacities of shallow and deep foundations, earth pressures on retaining structures, and slope stability.
Prerequisite: CIV_ENV 250-0.

CIV_ENV 355-0 Hydrogeology and Subsurface Contamination (1 Unit)
The integration of principles of geology, physics, chemistry, and mathematics required for understanding groundwater flow and how to perform aquifer tests, the fate and remediation of contaminants in the subsurface, and to develop numerical models for simulating these processes.
Prerequisite: fluid mechanics.

CIV_ENV 356-0 Transport Processes in Porous Media (1 Unit)
Transport processes in porous media including unsaturated flow, flow in deformable porous media, convective transport of solutes with hydrodynamic dispersion effects, and coupled flow phenomena with particular emphasis on electrokinetics.

CIV_ENV 358-0 Airphoto Interpretation (1 Unit)
Principles and practice of using aerial photographs to obtain information about natural features of the earth's surface, with emphasis on earth materials. Landforms, geological processes, rocks, and soils. Stereoscopic photographs, elements of photogrammetry.
Prerequisite: junior standing or consent of instructor.

CIV_ENV 361-0 Environmental Microbiology (1 Unit)
Basic principles and practical applications of microbiology to environmental issues, such as microbial contamination, degradation of organic contaminants, production of alternative fuels, and global climate change.

CIV_ENV 361-2 Public & Environmental Health (1 Unit)
Current problems in public and environmental health, such as the worldwide burden of major infectious diseases, emergence of new pathogens, and environmental reservoirs of infectious organisms.
Prerequisite: CIV_ENV 361-1 or consent of instructor.

CIV_ENV 363-0 Environmental Engineering Applications 1: Air and Land (1 Unit)
Nature and control of community air pollution. Sources, physical and chemical properties, and effects of major air pollutants; analytical measurements and monitoring of air pollutants; engineering and legislative control.
Prerequisite: CIV_ENV 260-0.

CIV_ENV 365-0 Environmental Laboratory (1 Unit)
Chemical and microbiological aspects of environmental engineering and science are explored through an integrated laboratory course.
Prerequisite: CIV_ENV 367-0.

CIV_ENV 367-0 Chemical Processes in Aquatic Systems (1 Unit)
Chemical principles for understanding and predicting the chemical composition and evolution of natural waters using an equilibrium approach. Applications to environmental issues such as metal speciation and toxicity, ocean acidification, carbon storage.
Prerequisite: BMD_ENG 250-0 or CHEM_ENG 211-0.

CIV_ENV 368-0 Sustainability: The City (1 Unit)
Exploration of the issues that motivate the design and engineering of sustainable resource use and development.

CIV_ENV 370-0 Emerging Organic Contaminants (1 Unit)
Fundamental molecular processes that govern the fate and transformation of emerging organic contaminants in natural and engineered environmental systems.
Prerequisite: CHEM 210-1 or consent of instructor.

CIV_ENV 371-0 Introduction to Transportation Planning and Analysis (1 Unit)
Analysis and design of solutions to transportation problems; introduction to selected operations research and statistical analysis techniques; use of case studies in urban transportation, intercity passenger transport, and freight movements.
Prerequisite: junior standing or consent of instructor.

CIV_ENV 376-0 Transportation System Operations (1 Unit)
Traffic-flow theory; vehicle and human factors, capacity analysis, intersection performance and control; management and control of arterial streets and networks; neighborhood traffic restraint, urban transit operations. Operations concepts and theories applied to actual problems through laboratory practice.
Prerequisite: basic understanding of calculus and statistics; knowledge of MATLAB desirable but not required.

CIV_ENV 385-1 Architectural Engineering and Design 1: Fundamentals (1 Unit)
Architectural engineering and design studios: architectural history, case studies in design, construction and management of buildings, and drawing and model building. Fundamental studio: basic architectural and structural design of a simple building project.
Prerequisite: junior standing in engineering or consent of instructor.

CIV_ENV 385-2 Architectural Engineering & Design 2: Intermediate (1 Unit)
Architectural engineering and design studios: architectural history, case studies in design, construction and management of buildings, and drawing and model building. Intermediate studio: architectural and structural design of a building project with multiple requirements.
Prerequisites: CIV_ENV 385-1 and junior standing in engineering; or consent of instructor.

CIV_ENV 385-3 Architectural Engineering & Design 3: Advanced Studio (1 Unit)
Architectural engineering and design studios: architectural history, case studies in design, construction and management of buildings, and drawing and model building. Advanced studio: architectural and structural design of a large, complex building project.
Prerequisites: CIV_ENV 385-2 and junior standing in engineering; or consent of instructor.

CIV_ENV 395-0 Special Topics in Civil and Environmental Engrg (1 Unit)
Topics suggested by students or faculty and approved by the department.

CIV_ENV 398-1 Community-based Design 1 (1 Unit)
Yearlong participation in two-or three-person team projects involving research, analysis, and/or design in the solution of environmental problems affecting primarily lower-income communities. Grade assigned only on completion of both units.
Prerequisite: consent of instructor.

CIV_ENV 398-2 Community-based Design 2 (1 Unit)
Yearlong participation in two-or three-person team projects involving research, analysis, and/or design in the solution of environmental problems affecting primarily lower-income communities. Grade assigned only on completion of both units.
Prerequisite: consent of instructor.

CIV_ENV 410-0 Theory of Plates and Shells (1 Unit)
Derivation of governing equations for plates, cylindrical shells and spherical shells, analytical and numerical methods for the solutions of elastic and inelastic problems, and civil engineering applications.

CIV_ENV 411-0 Micromechanics 1 (1 Unit)
Mechanics of microstructures of materials, such as continuum theory of dislocations, inclusions, inhomogeneities, cracks, and composite materials. Unified eigenstrain method employed.

CIV_ENV 413-0 Experimental Solid Mechanics (1 Unit)
Brief review of applied elasticity and fracture mechanics. Review of experimental methods for measuring mechanical behavior of solids, including deformation and fracture, fracture toughness and dynamic response at high strain rates. Methods discussed include strain gages, photoelasticity, birefringent coatings, moiré, digital image correlation, and fiber optic methods. CIV_ENV 413-0 and MECH_ENG 413-0 are co-listed.

CIV_ENV 414-1 Mechanics of Composite Materials 1 (1 Unit)
Introduction to basic concepts: fabrication of composite materials, micromechanics, macro-mechanics of unidirectional lamina, failure theories, mechanics of multidirectional laminate, lamination theory, hydrothermal effects, inter-laminar stresses, stress concentrations, structural design and optimization, and nondestructive evaluation. CIV_ENV 414-1 and MECH_ENG 414-1 are co-listed.

CIV_ENV 414-2 Mechanics of Composite Materials II (1 Unit)
Introduction to basic concepts: fabrication of composite materials, micromechanics, macro-mechanics of unidirectional lamina, failure theories, mechanics of multidirectional laminate, lamination theory, hydrothermal effects, inter-laminar stresses, stress concentrations, structural design and optimization, and nondestructive evaluation. CIV_ENV 414-2 and MECH_ENG 414-2 are co-listed.

CIV_ENV 415-0 Theory of Elasticity (1 Unit)

CIV_ENV 416-0 Computational Nanodynamics (1 Unit)
The objective of this course is to learn how to use theoretical and computational modeling tools to simulate dynamic solid mechanics phenomena at small scales. Topics covered include elementary concepts in dynamics, statistical mechanics, molecular interactions, coarse-graining strategies, and application of the molecular dynamics methodology to elasticity, self-assembly, vibrations, fragmentation and fracture problems of relevance to nanoscale, biological and biomolecular systems.

CIV_ENV 417-1 Mechanics of Continua 1 (1 Unit)
Introduction to mechanics of continuous media. Cartesian tensors; kinematics of deformable media; stress; balance laws; constitutive relations for selected solids and fluids.

CIV_ENV 417-2 Mechanics Continua 2 (1 Unit)
Kinematics of deformable media, thermodynamics and balance laws of continua, general theory of constitutive equations. Emphasis on large deformation theories; objective stress and deformation measures with applications in finite strain elasticity. Introduction to nonlinear and inelastic material behavior including applications in plasticity and viscoelasticity. Prerequisites: CIV_ENV 417-1 or equivalent.

CIV_ENV 419-0 Elastic Wave Propagation in Periodic Solids (1 Unit)
Introduction of elastodynamic wave equations in anisotropic solids, plane longitudinal, transverse, and surface waves, harmonic waves and pulses, energy considerations, reflection, transmission, and mode conversion, scattering and diffraction problems, reciprocity relations, piezoelectric materials, and band engineering using periodic solids and metamaterials. Prerequisites: CIV_ENV 415-0, MECH_ENG 363-0 or MECH_ENG 390-0, or equivalent.

CIV_ENV 420-0 Advanced Structural Analysis (1 Unit)
Solution of nonlinear equations for structures, shear center and center of twist of open and multicell cross sections, shear stresses in multicell closed cross sections, restrained warping torsion stresses.

CIV_ENV 421-0 Prestressed Concrete Design (1 Unit)

CIV_ENV 422-0 Inelastic Analysis of Structures (1 Unit)

CIV_ENV 423-0 Matrix Analysis of Structures (1 Unit)
Use of matrix methods for analysis of articulated structural systems, geometric matrices, stability, analysis of geometrically nonlinear systems, introduction to the finite element method.

CIV_ENV 424-0 Stability of Structures (1 Unit)
Buckling of perfect and imperfect columns, mathematical treatment of various types of stability problems and stability criteria, dynamic and static instability, and energy methods. Buckling of frames, trusses, and beams. Snap-through, elastic-plastic columns, creep buckling, and basic approach to buckling of two- and three-dimensional bodies.

CIV_ENV 425-0 Behavior of Reinforced Concrete (1 Unit)
Nonlinear behavior of reinforced concrete structural members. Assumptions underlying serviceability criteria, ductility for earthquake design, etc.

CIV_ENV 426-1 Advanced Finite Element Methods 1 (1 Unit)
Methods for treating material and geometric nonlinearities by finite elements; transient analysis: explicit and implicit time integration, partitioned methods, and stability; hybrid and mixed elements; finite elements for plates and shells; convergence, efficiency, and computer implementation. Co-listed with MECH_ENG 426-1.

CIV_ENV 426-2 Advanced Finite Element Methods 2 (1 Unit)
This course will cover the fundamentals of non-standard finite element formulations such as Moving Least Squares (MLS), Element Free Galerkin (EFG), Reproducing Kernel Particle Method (RKPM), Material Point Method (MPM), Arbitrary Lagrangian Eulerian (ALE) Formulations, and the eXtended Finite Element Method (XFEM). The course will also provide an in-depth investigation of advanced application of finite element analysis and interfacing user-developed material models with commercial finite element codes (Abaqus/LS-DYNA). Theory and implementation of computational plasticity, nonlinear elasticity, pressure-sensitive plasticity, and damage-based plasticity will be discussed. Material classes to be discussed are those commonly found in manufacturing, geomechanical, and biological applications such as ductile metals, soil, and tissue. Co-listed with MECH_ENG 426-2.

CIV_ENV 430-0 Quasibrittle Fracture and Scaling (1 Unit)

CIV_ENV 434-0 Total Quality Management (1 Unit)
How to achieve quality through continuous improvement of processes, customer satisfaction, and creating a team environment; includes data collection and analysis for process improvement.

CIV_ENV 435-0 Cost Engineering and Control (1 Unit)
Application of cost engineering for construction companies and projects; accounting methods; estimating process and bid preparation; labor cost; earned value analysis; accounting for equipment; cost-control concepts; cash flow management, changes and extras; claims. Prerequisites: PROJ_MGT 403-0 and PROJ_MGT 405-0

CIV_ENV 436-0 Construction Contracts & Dispute Resolution (1 Unit)

CIV_ENV 440-0 Environmental Transport Processes (1 Unit)
Processes controlling transport and fate of dissolved and suspended substances in natural and engineered environmental systems. Mass balances, hydrodynamic transport, phase and mass transfers; the fate of reactive species in complex environmental systems.

CIV_ENV 441-0 Chemical Microbial Interactions (1 Unit)
Applications of classical microbiology and molecular biology methods to study complex microbial communities. Includes a laboratory component. Prerequisites: CIV_ENV 361-1.

CIV_ENV 442-0 Environmental Biotechnology for Resource Recovery (1 Unit)

CIV_ENV 443-0 Microbial Ecology for Resource Recovery (1 Unit)
This course provides students with an overview of microbial ecology—that is, the study of interactions between microorganisms and the environment and how complex microbial communities are linked function and stability of both engineered and natural systems.

CIV_ENV 444-0 Physical/Chemical Processes in Environmental Control (1 Unit)
Theory and practice of separations and conversions in water quality and residuals management, coagulation, adsorption, ion exchange, oxidation, sedimentation, flocculation, filtration. Prerequisites: CIV_ENV 367-0, CIV_ENV 440-0 or equivalent.

CIV_ENV 445-0 Environmental Systems Laboratory (1 Unit)
Use of a variety of experimental methods to probe processes occurring in water treatment operations and complex natural systems. Emphasis on bringing multiple tools to bear in order to evaluate overall system behavior.

CIV_ENV 446-0 Environmental Analytical Chemistry (1 Unit)
Theory and the applications of analytical chemistry as applied to complex, multiphase environmental systems. Prerequisites: CIV_ENV 367-0.

CIV_ENV 447-0 Molecular Microbiology (1 Unit)
An in-depth look at current molecular methods used to study environmental microbiology. Fundamentals of molecular microbiology, creative and critical analysis of literature through proposal writing and reviewing. Topics focus on polymerase chain reaction and derivatives; DNA sequencing; proteomics & proteogenomics, and metabolomics.

CIV_ENV 448-0 Computational Chemodynamics (1 Unit)
An in-depth understanding of the processes that govern the fate of chemicals in the environment by developing computational tools used to quantify the concentrations of contaminants and nutrients. Numerical methods focus on solving: multiphase equilibrium problems, box models, reaction networks and kinetics, the interplay between transport and reaction, partitioning, and trophic relationships.

CIV_ENV 450-1 Soil Mechanics 1 (1 Unit)

CIV_ENV 450-2 Soil Mechanics 2 (1 Unit)

CIV_ENV 450-3 Soil Mechanics 3 (1 Unit)

CIV_ENV 451-0 Engineering Properties of Soils (1 Unit)
Determination and interpretation of engineering properties of soils. Laboratory testing procedures and methods of evaluation and control. Report writing.

CIV_ENV 452-0 Unsaturated Soil Mechanics (1 Unit)
Principles of the hydraulics and mechanics of natural and engineered soils characterized by unsaturated conditions.

CIV_ENV 453-0 Rock Mechanics (1 Unit)
Engineering properties and behavior of rock masses. Shear strength of rock, in situ and laboratory tests of strength, rock fracture, three-dimensional geometry of joint systems, stability of rock masses, in situ stress determination, and deformability of rock masses.

CIV_ENV 454-0 Constitutive Models for Soils (1 Unit)
Numerical models of effective and total stress-strain response of soils; non-linear pseudo-elastic, elasto-plastic and bounding surface models; parameter identification and applications. Prerequisites: CIV_ENV 450-1 or permission of instructor.

CIV_ENV 455-0 Plasticity and Limit Analysis (1 Unit)
Fundamental theory of and computational tools for plasticity, including the concepts of yielding and plastic flow in materials and, by extension, the concepts of limit (collapse) loads and collapse mechanisms in boundary value problems.

CIV_ENV 456-0 Computational Geotechnics (1 Unit)
Fundamentals of the finite element method for geotechnical analysis. This course provides an essential skillset to those entering the practice of geotechnical engineering, and builds a foundation for future study and inquiry to those who are engaged primarily in research.

CIV_ENV 457-0 Environmental Geotechnics (1 Unit)

CIV_ENV 458-0 Soil Dynamics (1 Unit)
Dynamics of soils and soil-foundation systems; nuclear weapon effects, earthquake response, vibrations of machine foundations, reactions due to impact equipment, industrial noise and blast effects, fatigue concepts, wave propagation and attenuation, blast-resistant construction, and linear and nonlinear systems.

CIV_ENV 461-0 Soil Science for Environmental Engineering (1 Unit)
Fundamental properties and behavior of soil systems, with emphasis on soil physics, soil chemistry, and soil microbiological and biochemical reactions applied to contaminant transport and fate. Includes laboratory experience with soil.

CIV_ENV 467-0 Advanced Environmental Chemistry (1 Unit)
Principles and applications needed to develop advanced problem-solving techniques in environmental chemistry. Major topics include applied thermodynamics, environmental organic chemistry, and problem solving for acid/base, complexation, precipitation/dissolution, and redox.

CIV_ENV 468-0 Metals in the Environment (1 Unit)
A course on concepts, fundamentals, and tools used for studying the fate of metals in the environment. The emphasis is placed on the processes that control and regulate the chemical speciation of metals in aquatic environments and inform about their interactions with biological species.

CIV_ENV 471-1 Transportation Systems Analysis 1 (1 Unit)
Applications of optimization methods to analysis, design, and operation of transportation and logistics networks. Network equilibrium; flow prediction in congested multicommodity networks; vehicle routing and fleet management; dynamic and stochastic transportation network modeling.
Prerequisites: IEMS 310-0 or equivalent background.

CIV_ENV 471-2 Transportation Systems Analysis 2 (1 Unit)
Applications of optimization methods to analysis, design, and operation of transportation and logistics networks. Network equilibrium; flow prediction in congested multicommodity networks; vehicle routing and fleet management; dynamic and stochastic transportation network modeling.
Prerequisites: IEMS 310-0 or equivalent background.

CIV_ENV 472-1 Transportation System Operations and Control 1: Urban Networks (1 Unit)
Concepts and advanced methodologies for the design of control strategies for transportation systems operations, focusing on urban traffic networks.

CIV_ENV 472-2 Transportation System Operations and Control 2: Scheduled Modes and Real-Time (1 Unit)
Concepts and advanced methodologies for the design of service networks, operating plans and control strategies for scheduled transportation modes and real-time services.
Selected topics in structural engineering and materials and mechanics of materials and solids.

CIV_ENV 512-3 Structural Engineering & Mechanics Sem (0 Unit)
Selected topics in structural engineering and materials and mechanics of materials and solids.

CIV_ENV 515-1 Geotechnics Seminar (0 Unit)
Discussion of classical and current literature in the field.

CIV_ENV 515-2 Geotechnics Seminar (0 Unit)
Discussion of classical and current literature in the field.

CIV_ENV 516-1 Seminar in Environmental Engineering & Science (0 Unit)
Topics vary. Examples: environmental microbiology; innovation technologies for recycling, recovery, treatment of chemical residuals; environmental policy; public health; water and waste treatment processes; contaminant fate and impact in nature.

CIV_ENV 516-2 Seminar in Environmental Engineering and Science (0 Unit)
Topics vary. Examples: environmental microbiology; innovation technologies for recycling, recovery, treatment of chemical residuals; environmental policy; public health; water and waste treatment processes; contaminant fate and impact in nature.

CIV_ENV 516-3 Seminar in Environmental Engineering and Science (0 Unit)
Topics vary. Examples: environmental microbiology; innovation technologies for recycling, recovery, treatment of chemical residuals; environmental policy; public health; water and waste treatment processes; contaminant fate and impact in nature.

CIV_ENV 517-1 Seminar in Transportation Engineering (0 Unit)
Selected topics in transportation engineering.

CIV_ENV 517-2 Seminar in Transportation Engineering (0 Unit)
Selected topics in transportation engineering.

CIV_ENV 517-3 Seminar in Transportation Engineering (0 Unit)
Selected topics in transportation engineering.

CIV_ENV 519-0 Responsible Conduct of Research Training (0 Unit)
Selected topics in project management and engineering.

CIV_ENV 533-1 Project Management Seminar (0 Unit)
Selected topics in project management and engineering.

CIV_ENV 533-2 Project Management Seminar (0 Unit)
Selected topics in project management and engineering.

CIV_ENV 533-3 Project Management Seminar (0 Unit)
Selected topics in project management and engineering.

CIV_ENV 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Clinical Psychology (CLIN_PSY)

CLIN_PSY 402-0 Psychological Assessment I (1 Unit)
This course provides an introduction to psychological assessment, focusing on developing knowledge and proficiency in the assessment of intellectual and related cognitive abilities in adults, children, and special populations, as well as proficiency in psychological report writing.

Prerequisite: CLIN_PSY 402-0 or equivalent.

CLIN_PSY 404-0 Psychological Assessment III (1 Unit)
Development of a) skills in diagnostic assessment of psychopathology using semi-structured interviews; b) skills in the use/interpretation of self-report measures of personality and psychological functioning; c) familiarity with other approaches to psychological assessment (i.e., performance based or projective measures); d) appreciation of the role of cultural/ diversity issues in the context of psychological assessment.

Prerequisite: CLIN_PSY 403-0 or equivalent.

CLIN_PSY 407-0 Child Psychological Assessment (1 Unit)
This course aims to increase knowledge competencies in psychological and neuropsychological assessment of children and adolescents, skill competencies in test administration, scoring, and interpretation, and skill competencies in report writing.

CLIN_PSY 408-0 Psychopathology Laboratory (0.5 Unit)
This course supplements the science-focused Psychopathology course by further developing practical knowledge in DSM5 diagnostic criteria, diagnostic interviewing, and differential diagnoses. The class is meant to increase practical knowledge and skills needed to perform intake assessments at clinical placements.

CLIN_PSY 410-0 Psychodynamic Traditions (1 Unit)
Psychoanalytic theories and concepts; their impact upon contemporary thought, theory, and clinical practice. Recent developments and applications reviewed in the light of current evidence and criticism.

CLIN_PSY 411-0 History and Systems of Psychology (1 Unit)
The primary goal of this self-directed course is to develop knowledge in the origins and development of major ideas in the discipline of psychology. This course supplements the historical and systems content already provided in other courses, and is intended for students that have not already completed a documented evaluative educational experience in the history and systems of psychology prior to matriculating to Northwestern.

CLIN_PSY 412-1 Cognitive Psychology (0 Unit)
Classical and contemporary research and theory in cognitive psychology, cognitive neuropsychology, and cognitive neuroscience.

CLIN_PSY 412-2 Cognitive Psychology (0 Unit)
Classical and contemporary research and theory in cognitive psychology, cognitive neuropsychology, and cognitive neuroscience. Prerequisite: CLIN_PSY 412-1.

CLIN_PSY 412-3 Cognitive Psychology (1 Unit)
Classical and contemporary research and theory in cognitive psychology, cognitive neuropsychology, and cognitive neuroscience. Prerequisite: CLIN_PSY 412-2.

CLIN_PSY 413-0 Advanced Social Psychology (1 Unit)
Development of advanced, graduate-level knowledge of the social basis of behavior through social psychological principles underpinning human behavior, specifically, understanding a) major theories related to the social basis of behavior; b) seminal and recent empirical evidence for the social basis of behavior; c) application of the major theories and evidence of the social basis of behavior to clinical psychology.

CLIN_PSY 414-0 Diversity in Psychological Science and Practice (1 Unit)
Knowledge of theory and research related to human diversity, b) basic skills in approaching diversity in clinical practice and research, c) related ethical issues, d) self-awareness, e) developing a sense of cultural humility, f) sensitivity to the centrality of diversity on the lives of patients, research participants, and colleagues, g) knowledge of general domains of diversity.

CLIN_PSY 415-1 Scientific and Professional Ethics in Psychology (1 Unit)
Understanding of ethical and professional concerns in the field of clinical psychology. Using readings on ethics, responsible conduct of research, and case examples, the course addresses professional issues associated with the clinical practice of psychology, research, teaching, supervision, forensic activities, administration, and other professional activities. This course fully satisfies NIH’s "Instruction in the Responsible Conduct of Research" requirement (NOT-OD-10-019).

CLIN_PSY 416-0 Psychopathology (1 Unit)
The overall goal of this course is to develop foundational knowledge in theory, etiology, and presentation of psychological and psychiatric disorders and to develop skills in conducting diagnostic assessments and treatment interventions of psychological and psychiatric disorders.

CLIN_PSY 417-0 Behavioral Neuroscience (1 Unit)
Development of advanced knowledge in the multiple biological underpinnings of behavior and mental processes, including a) architecture of the CNS and functions of neurons; b) role of neurotransmitters and receptors in the CNS; c) brain development/plasticity; and d) CNS and sensory processes, motor control, regulatory systems, cognition, behavior, emotion, and consciousness.

CLIN_PSY 426-0 Research Methods I (1 Unit)
This course provides statistical foundations of applied psychological research, including an introduction to elementary statistical principles and techniques (e.g., basic parametric and nonparametric statistics, analysis of variance, simple factorial designs, correlation, and regression).

CLIN_PSY 427-0 Research Methods II (1 Unit)
This course continues to develop skills in advanced statistical topics and the ability to conduct statistical analysis independently. Topics covered include parametric and nonparametric statistics, advanced analysis of variance models, and advanced regression models. Prerequisite: CLIN_PSY 426-0.

CLIN_PSY 428-0 Research Methods III (1 Unit)
This course continues to develop skills in advanced statistical topics and the ability to conduct statistical analysis independently. Topics covered include mixed designs, multivariate analysis of variance, survival analysis, exploratory factor analysis, loglinear models, and hierarchical linear models. Prerequisite: CLIN_PSY 427-0.

CLIN_PSY 429-0 Advanced Research Methodology (1 Unit)
An examination of validity, measurement, experimental design, sampling, data management and meta-analysis. Students design their own research proposals.

CLIN_PSY 432-0 Family Therapy (1 Unit)
Understanding of the historical roots of family therapy and its evolution toward evidence-based practice. Through live supervision, this course is designed to not only increase knowledge of family therapy, but also develop skills in understanding family-based transactional processes, family-based mechanisms of change, and comfort with Integrative Module-based Family Therapy.

CLIN_PSY 441-0 Introduction to Psychotherapy (1 Unit)
Introduction to the major theories of psychotherapeutic action and change, including basic psychotherapy skills common across approaches as well as those specific to each theoretical perspective, as well as development of awareness of cultural diversity, contextual factors, and individual differences in psychotherapy.

CLIN_PSY 442-0 Sexual Disorders and Couple Therapy (1 Unit)
This course develops knowledge and skills in the assessment and treatment of sexual disorders and in the treatment of relationship dysfunction through couple therapy. Sexual disorders to be covered will include gender disorders, problematic sexual behavior, sexual dysfunctions and professional sexual misconduct. The predominant approaches to couple therapy will be examined.

CLIN_PSY 443-0 Advanced Psychotherapy (1 Unit)
This course further develops knowledge and skill competencies in various psychotherapy models, providing a theoretical background for the model, model-specific case formulation, common interventions used within the model, and presentation of case studies illustrating each model. Prerequisite: CLIN_PSY 441-0.

CLIN_PSY 444-0 Cognitive-Behavior Therapies (1 Unit)
This course develops an understanding of the theoretical underpinnings of cognitive-behavior therapy, cognitive-behavioral case formulation, practical aspects of key cognitive-behavioral techniques across disorders, flexible application of cognitive behavioral therapy to complex and/or unique problems in various contexts and settings.

CLIN_PSY 445-0 Cognitive and Behavioral Treatments for Depression (0.5 Unit)
The goal of this seminar is to synthesize theory, skills, and experience in Behavioral Activation and Cognitive Therapy for depression to strengthen your adherence and competency. Weekly lectures include didactics, rehearsal, demonstrations, and experiential exercises.

CLIN_PSY 446-0 Acceptance and Commitment Therapy (1 Unit)
This course develops foundational knowledge in the research, theory, and practice of Acceptance and Commitment Therapy. Prerequisite: CLIN_PSY 441-0.

CLIN_PSY 447-0 Dialectical Behavior Therapy (1 Unit)
This course is designed to develop foundational knowledge in the research, theory, and practice of Dialectical Behavior Therapy (DBT).

CLIN_PSY 448-0 Positive Psychology in Clinical Practice (1 Unit)
This course is designed to develop foundational knowledge in the research, theory, and practice of Positive Psychology.

CLIN_PSY 450-0 Cognitive Psychology Seminar (0.25 Unit)
This course develops knowledge of and familiarity with the latest research in the field of Cognitive Psychology through readings, presentations, and discussion. The secondary purpose of this course is to develop skills in oral presentation and applying recent research in the field of Cognitive Psychology to future research, grant development, and clinical assessment and treatment.

**CLIN_PSY 451-0 Diversity in Psychology Seminar (0.25 Unit)**
This course develops knowledge of and familiarity with the latest research related to Diversity in Psychological Science and Practice through readings, presentations, and discussion. The secondary purpose of this course is to develop skills in oral presentation and applying recent research in the field of Diversity to future research, grant development, and clinical assessment and treatment.

**CLIN_PSY 452-0 Social Psychology Seminar (0.25 Unit)**
This course develops knowledge of and familiarity with the latest research in the field of Social Psychology through readings, presentations, and discussion. The secondary purpose of this course is to develop skills in oral presentation and applying recent research in the field of Social Psychology to future research, grant development, and clinical assessment and treatment.

**CLIN_PSY 462-0 Child and Adolescent Psychotherapy (1 Unit)**
This course examines how cognitive and behavioral models can be used in conceptualizing and treating behavioral and emotional disorders among youth. Evidence for the efficacy and effectiveness of alternative interventions, as well as clinical issues related to the practice of CBT with children, adolescents, and families are reviewed.

**CLIN_PSY 466-0 Child Psychopathology (1 Unit)**
Psychopathologies of childhood, emphasizing behavior and emotional disorders, conduct disorders, the psychoses of childhood, children's physical handicaps, chronic health disorders, mental retardation, learning disabilities and hyperactivity, transient situational disorders, and special symptom disorders.

**CLIN_PSY 471-0 Principles of Neuroimaging (1 Unit)**
This course provides graduate-level exposure to: the physical, biological, and neuroscience basis of neuroimaging, the technologies of in vivo neuroimaging, the application of these technologies to understanding questions in neuroscience, and an introduction to the design and analysis of neuroimaging experiments.

**CLIN_PSY 472-0 Brain & Behavior: Introduction to Neuropsychology (1 Unit)**
This course introduces students to the field of clinical neuropsychology, reviewing its history and examining the classical clinical conditions that laid the foundations for modern day neuropsychology and cognitive neuroscience. Key clinical syndromes (e.g., aphasia, apraxia, agnosia, amnesia, frontal/executive disorders) and mechanisms of disease (stroke, trauma, neurodegenerative disease) are reviewed with emphasis on clinically relevant features.

**CLIN_PSY 473-0 Behavioral Neuroanatomy (1 Unit)**
This course familiarizes students with the structure and function of the human central nervous system in an effort to establish clinical relevance. The course aims to develop knowledge of the location and function of key human brain regions known to support cognition and behavior, as well as understanding of how lesions or disruption to these regions produce certain neuropsychological syndromes.

**CLIN_PSY 474-1 Behavioral Neurology (0 Unit)**
Overview of the characteristic signs, symptoms, and presentation of various neurologic and neuropsychiatric syndromes evaluated in a behavioral neurology setting and their underlying neuroanatomical and functional mechanisms.

**CLIN_PSY 474-2 Behavioral Neurology (0 Unit)**
Overview of the characteristic signs, symptoms, and presentation of various neurologic and neuropsychiatric syndromes evaluated in a behavioral neurology setting and their underlying neuroanatomical and functional mechanisms. Prerequisite: CLIN_PSY 474-1.

**CLIN_PSY 474-3 Behavioral Neurology (1 Unit)**
Overview of the characteristic signs, symptoms, and presentation of various neurologic and neuropsychiatric syndromes evaluated in a behavioral neurology setting and their underlying neuroanatomical and functional mechanisms. Prerequisite: CLIN_PSY 474-2.

**CLIN_PSY 475-0 Neuropsychological Assessment (1 Unit)**
This course provides a hands-on introduction to the practice of neuropsychological assessment. The course aims to provide a theoretical understanding of neuropsychological assessment theory, and for students to achieve basic competence in the administration, scoring, and interpretation of common neuropsychological assessment instruments. Prerequisites: CLIN_PSY 402-0; CLIN_PSY 403-0; CLIN_PSY 404-0.

**CLIN_PSY 476-0 Health Psychology (1 Unit)**
This course provides an understanding of the application of psychological practices to common medical conditions, including knowledge of theory and research related to behavioral medicine, awareness of the training, professional and ethical issues related to behavioral medicine, the scientific, theoretical, empirical, and contextual bases of behavioral medicine interventions, and the role of evidence-based practice in behavioral medicine.

**CLIN_PSY 477-0 Motivation and Self-Control in Health Behavior (1 Unit)**
This course provides an overview of current motivational theories of impulse control and self-regulation, and how to apply these concepts in psychotherapy and medical adherence counseling. Although this course review the history of the study of motivation, the primary focus is on current conceptions and their relevance for the clinical setting, particularly in health psychology.

**CLIN_PSY 478-0 Primary Care Psychology (0.5 Unit)**
This course examines the role of clinical health psychology in primary care medicine, including understanding of primary care as the "front line" for the mental and physical health needs of patients, the scientific, theoretical, empirical, and contextual bases of primary care psychology, the training, professional, and ethical issues related to primary care psychology, and techniques often used in primary care.

**CLIN_PSY 481-0 Psychopharmacology (1 Unit)**
Development of knowledge and familiarity with psychopharmacology and common psychopharmacologic agents used in the treatment of psychiatric disorders.

**CLIN_PSY 482-0 Mental Health Policy (1 Unit)**
This course provides an overview of mental health policy in the United States, covering the history of mental health policymaking, recent policy changes, and implications for the mental health research, service, and the US population. Principles of mental health recovery, financing and management of healthcare systems, and implications for future system reform will also be addressed.

**CLIN_PSY 483-0 Forensic Neuropsychology and Psychology (1 Unit)**
This course provides a foundation of knowledge in the interaction of the legal system with neuropsychology and psychology. Student will develop knowledge and skill competencies in the legal system, case
law, admissibility of evidence, mental health law, neuropsychology of violence and aggression, neuropsychology of antisocial behavior and psychopathy, competency assessment, capital sentencing, forensic assessment of sex offenders and dangerousness.

**CLIN_PSY 498-0 Life-Span Developmental Psychology (1 Unit)**
This course examines psychological development across the lifespan, including biological, cognitive, social, and emotional development, with particular attention to environmental and cultural influences. Specific aims include an overview of major theories of development, and synthesizing of development research across multiple domains.

**CLIN_PSY 490-1 Professional Development in Clinical Psychology (0 Unit)**
This course orients students to the MA program, matches students with available mentors/labs, and introduces students to career options in academic clinical psychology. It refines MA students’ interests in academic clinical psychology and helps them prepare for the next steps in their careers.

**CLIN_PSY 490-2 Professional Development in Clinical Psychology (0 Unit)**
This course orients students to the MA program, matches students with available mentors/labs, and introduces students to career options in academic clinical psychology. It refines MA students’ interests in academic clinical psychology and helps them prepare for the next steps in their careers.

**CLIN_PSY 490-3 Professional Development in Clinical Psychology (0 Unit)**
This course orients students to the MA program, matches students with available mentors/labs, and introduces students to career options in academic clinical psychology. It refines MA students’ interests in academic clinical psychology and helps them prepare for the next steps in their careers.

**CLIN_PSY 490-4 Professional Development in Clinical Psychology (1 Unit)**
This course orients students to the MA program, matches students with available mentors/labs, and introduces students to career options in academic clinical psychology. It refines MA students’ interests in academic clinical psychology and helps them prepare for the next steps in their careers.

**CLIN_PSY 498-0 Special Topics in Clinical Psychology (1 Unit)**
New course possibilities not yet offered regularly and seminar offerings by visiting faculty in their areas of special interest and expertise.

**CLIN_PSY 498-1 Special Topics in Clinical Psychology (1 Unit)**

**CLIN_PSY 498-2 Special Topics in Clinical Psychology (1 Unit)**

**CLIN_PSY 498-3 Special Topics in Clinical Psychology (1 Unit)**

**CLIN_PSY 498-4 Special Topics in Clinical Psychology (1 Unit)**

**CLIN_PSY 499-0 Independent Study (1 Unit)**
Permission of instructor and department required. May be repeated for credit.

**CLIN_PSY 523-0 Practicum (1 Unit)**
Diagnostic evaluation, clinical assessment, and psychotherapy experiences with hospitalized and clinic populations of various ages and problems. May be repeated for credit.

**CLIN_PSY 526-0 Interprofessional Education Seminar (1 Unit)**
This course is designed to introduce supervision, consultation, and interprofessional/interdisciplinary skills in a seminar format.

**CLIN_PSY 550-0 APA-Accredited Internship (Full-Time, 1-year) (0 Unit)**
Clinical Internship requirement completed at an APA-accredited internship site, full-time for 1 year.

**CLIN_PSY 590-0 Research (1-3 Units)**
Individual research under faculty supervision in appropriate laboratories, hospitals, and clinics. May be repeated for credit.

**Cognitive Science (COG_SCI)**

**COG_SCI 366-0 Cognitive Science Proseminar (1 Unit)**
New and ongoing research by Northwestern faculty. Prerequisite: consent of instructor.

**COG_SCI 401-0 Mind and Brain (1 Unit)**
An introduction to cognitive science and cognitive neuroscience. Addressing fundamental questions about mental and neurocognitive structure and function through the integration of methodological and theoretical approaches from across traditional disciplines.

**COG_SCI 460-0 Special Topics in Cognitive Science (1 Unit)**
Topic to be announced. Prerequisites vary. May be repeated for credit with different topic.

**Communication Sciences and Disorders (CSD)**

**CSD 302-0 Anatomy and Physiology of the Peripheral Hearing Mechanism (1 Unit)**
Gross and fine structure; function of the peripheral auditory system. Prerequisites: junior standing or above, CSD 202-0, or consent of instructor.

**CSD 306-0 Psychoacoustics (1 Unit)**
Principles underlying perception of pitch, loudness, auditory patterns, and speech. Psychophysical procedures for studying psychoacoustics and the impact of hearing impairment are considered.

**CSD 310-0 Biological Foundations of Speech and Music (1 Unit)**
Anatomy and physiology of the central auditory pathway, experience-related neural plasticity, right/left brain specialization, audiovisual integration, auditory learning and perception, and neural encoding of speech and music. Crosslisted with CSD 410-0 and SAI 502-0. Prerequisite: junior standing or consent of instructor.

**CSD 334-0 Delivery Systems in Speech & Language Pathology (1 Unit)**
Organization and administration of speech language pathology services in schools, health care agencies, and private practice.

**CSD 369-0 Special Topics in Communication Sciences and Disorders (0.5-1 Unit)**
Current scientific and professional problems in communication sciences and disorders. Topics vary by quarter.

**CSD 376-0 Diagnostic & Remedial Approaches for Children With Learning Problems (1 Unit)**
Introduction to the field of learning disabilities and its theoretical perspectives, assessment, and instruction principles, and to the process of clinical teaching. Emphasis on instruction, accommodation, service delivery, progress monitoring, and transition.
CSD 404-1 Experimental Design and Statistics in Communication Sciences and Disorders (1 Unit)

CSD 404-2 Experimental Design and Statistics in Communication Sciences and Disorders (1 Unit)

CSD 405-1 Instrumentation and Methods for Psychoacoustics (1 Unit)
Hands-on psychoacoustic instrumentation and methods, including required technical background. Students will complete at least one project using techniques learned in the course.
Prerequisites: CSD 306-0 or equivalent, and computer programming.

CSD 405-2 Advanced Psychoacoustics (1 Unit)
Development of in-depth understanding of auditory filtering and temporal resolution in normal and hearing-impaired listeners, comodulation masking release and pitch perception, all viewed through models of the peripheral auditory system.
Prerequisites: CSD 302-0, CSD 306-0, and CSD 405-1 or equivalents.

CSD 410-0 Biological Foundations of Speech and Music (1 Unit)
Anatomy and physiology of the central auditory pathway, experience-related neural plasticity, right/left brain specialization, audiovisual integration, auditory learning and perception, and neural encoding of speech and music. Crosslisted with CSD 310-0 and SAI 502-0.
Prerequisite: junior standing or consent of instructor.

CSD 412-0 Scientific Writing (1 Unit)
Principles of scientific writing for journals, dissertations, and grant proposals. Emphasis on mastering the structures for presenting concepts and data.

CSD 436-0 Working with Individuals with Cerebral Palsy (0.5 Unit)
An overview of cerebral palsy, including such topics as causes and types, symptomatology, typical and atypical motor development, associated disorders, speech and language and feeding characteristics of individuals with various types of cerebral palsy, and assessment and treatment.

CSD 444-0 Development and Disorders of Mathematics (1 Unit)
Theories and research on mathematical development and disorders. Identification, assessment, and remediation of disorders of mathematics and related areas.

CSD 448-0 Clinical Writing for CSD (0.5 Unit)
Written documentation in professional practice. Knowledge of strategies for improving the quality of treatment reports and diagnostic evaluations. Strategies will focus on selection and prioritization of content, organization, clarity and editing.
Prerequisite: graduate standing.

CSD 499-0 Independent Study (0.5-3 Units)
May be repeated for credit. Consent of instructor and department required.

CSD 507-0 Neural Mechanisms of Language Processing (1 Unit)
Topics in brain-behavior relationships, emphasizing normal and abnormal speech and language.

CSD 511-0 Translational Research in Communication Sciences and Disorders (1 Unit)
Seminar on how all aspects of communication-sensory processing, cognitive/language factors, and motor processes interact in normal and disordered functioning, and how research can address treatment outcomes.

CSD 513-0 Seminar: Problems in Speech Science (1 Unit)
Issues in speech science. Open to doctoral students.

CSD 514-0 Topics in Peripheral Auditory Neuroscience (1 Unit)
Problems in the biophysics and physiology of hearing.

CSD 516-0 Seminar: Experimental and Theoretical Aspects of Audiology (1 Unit)
Open to graduate students pursuing the PhD degree.

CSD 525-0 Seminar: Topics in Central Auditory Neuroscience (1 Unit)
Neurobiology underlying perception and learning of complex sounds such as speech and music.
Prerequisites: CSD 302-0.

CSD 544-0 Responsible Conduct of Research in Communication Sciences and Disorders (0 Unit)
Overview of the Responsible Conduct of Research, with topics including the responsible conduct of CSD research in key areas identified by the National Institutes of Health; expectations about conduct within the research enterprise; research misconduct; and the role of the CSD scientist beyond the lab, including the global implications of research.

CSD 545-0 Seminar: Professional Development (1 Unit)
Professional issues in the field of communication sciences and disorders. Topics include ethics, grants and funding, peer reviews and publishing, postdoctoral experiences, interviewing, and tenure.

CSD 546-0 Directed Teaching in Communication Sciences and Disorders (1 Unit)
Guided teaching experience. Preparation and delivery of class lectures, as well as observation of teaching methods, preparation of the course outline, selection of readings, and writing of exam questions.

CSD 550-1 Research Foundations in Communication Sciences and Disorders (1 Unit)
An introduction to scientific thinking as applied to Communication Sciences and Disorders. Topics to be covered include the scientific method, hypotheses versus predictions, the purpose of data collection, previous evidence, and scientific argumentation.

CSD 550-2 Research Foundations in Communication Sciences and Disorders (1 Unit)
Essential concepts in designing and interpreting experiments in communication sciences and disorders. The range of methods commonly used in sub-disciplines of CSD (i.e., biology, psychology and clinical studies), with an eye to the strengths and weaknesses of each. Selection of papers of interest on a given topic, and critique of the research design.

CSD 550-3 Research Foundations in Communication Sciences and Disorders (1 Unit)
Focus on how to convey scientific ideas and findings, building on scientific thinking and experimental design covered in previous courses. Emphasis is placed on how to communicate effectively across spoken, written, and visual formats, and to a variety of audiences. Iterative assignments on different types of communication (e.g., elevator speech, short research talk, abstract) throughout the quarter.

CSD 551-0 Topics in Communication Sciences and Disorders (1 Unit)
Reading, reviewing, and critiquing published research in a specific topic area in communication sciences and disorders. Topics to be announced.

**CSD 552-1 Laboratory Experiences in Communication Sciences and Disorders (1 Unit)**
Experience in laboratory research in communication sciences and disorders.
Prerequisites: Faculty permission.

**CSD 552-2 Laboratory Experiences in Communication Sciences and Disorders (1 Unit)**
Experience in laboratory research in communication sciences and disorders.
Prerequisites: Faculty permission.

**CSD 552-3 Laboratory Experiences in Communication Sciences and Disorders (1 Unit)**
Experience in laboratory research in communication sciences and disorders.
Prerequisites: Faculty permission.

**CSD 553-0 Computational Modeling in Communication Sciences and Disorders (1 Unit)**
Introduction to the use of computer programming and computational modeling to address problems in communication sciences and disorders.

**CSD 575-0 Advanced Seminar: Current Topics in Learning Disabilities (1 Unit)**
Review of areas of current research. May be repeated for credit with change of topic.

**CSD 589-0 Advanced Study and Research in Differential Diagnosis of Learning Disabilities (1 Unit)**
Individual research in differential diagnosis of language and learning disabilities in adults.

**CSD 590-0 Research (1-3 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

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**Communication Studies (COMM_ST)**

**COMM_ST 301-0 Current Issues in Privacy (1 Unit)**
The texture of interactions affecting privacy: government and workplace monitoring and surveillance, invasion of privacy by social media, disclosure to unintended Internet audiences, database aggregation, privacy and the person.

**COMM_ST 302-0 Law of the Creative Process (1 Unit)**
Principles of copyright, contracts, and entertainment business practices from the perspective of the producer, artist, and creator.

**COMM_ST 314-0 Rhetoric and Public Commemoration (1 Unit)**
Public commemoration as a rhetorical phenomenon. Through discussion of scholarly literature and production of research papers, students investigate questions such as: How do societies remember the past? What do the strategies for remembering the past teach us about the present? How are 'collective memories' produced and challenged?.

**COMM_ST 315-0 Rhetoric of Social Movements (1 Unit)**
Study of traditional theories of opposition derived from sociological and rhetorical analyses of mass movements. Examines new social movements such as advocacy groups related to abortion, animal rights, feminism, and other local and national issues.

**COMM_ST 321-0 Media & Publics Across Cultures (1 Unit)**
Relationship between culture and media in an increasingly globalized world, examined through analysis of ethnographic case studies and theoretical texts.

**COMM_ST 323-0 New Media as Popular Culture (1 Unit)**
How rituals, practices, and relationships enabled by new-media cultural forms shape and reconstitute everyday life. Emphasis on research implementing qualitative and interpretive methods.

**COMM_ST 324-1 Rhetoric of U.S. Women's Rights, Part I (1 Unit)**
Today women cause no sensation when they address public gatherings, but in the 1820s, when American social reformers broke the taboo, such behavior was scandalous. Development of the new women's oratorical tradition from its origins through the early 20th century.

**COMM_ST 324-2 Rhetoric of U.S. Women's Rights, 1920-Present (1 Unit)**
Today women cause no sensation when they address public gatherings, but in the 1820s, when American social reformers broke the taboo, such behavior was scandalous. Continued development from 1920 to the present.

**COMM_ST 325-1 Rhetorical History of the United States I (1 Unit)**
History of the United States, as studied through key rhetorical texts. Focus on moments of political crisis and cultural change. Colonial period to the outbreak of the Civil War.

**COMM_ST 325-2 Rhetorical History of the United States II (1 Unit)**
History of the United States, as studied through key rhetorical texts. Focus on moments of political crisis and cultural change. Civil War to World War I.

**COMM_ST 325-3 Rhetorical History of the United States III (1 Unit)**
History of the United States, as studied through key rhetorical texts. Focus on moments of political crisis and cultural change. World War I to the 1960s.

**COMM_ST 330-1 Contemporary Problems in Freedom of Speech I (1 Unit)**
Personal freedom and public communication under the US Constitution. Principles, forms of reasoning, and court decisions governing conflicts between freedom of speech and public order, property rights, personal security, morality, and racial and gender equality in traditional, mass, and new electronic media.

**COMM_ST 330-2 Contemporary Problems in Freedom of Speech II (1 Unit)**
Personal freedom and public communication under the US Constitution. Analysis of selected issues introduced in COMM_ST 330-1. Prerequisite: COMM_ST 330-1.

**COMM_ST 332-0 The Rhetoric of Multiculturalism (1 Unit)**
Examination of debates about the meaning and significance of cultural pluralism in American and global politics and about the rhetorical, communicative, and political challenges this condition raises.

**COMM_ST 333-0 Girlhood in Public Culture (1 Unit)**
Why girls have figured so centrally in 20th century popular culture; why the concept of girlhood itself has been so widely debated within public culture more generally; how girls themselves have responded to public representations of girlhood.

**COMM_ST 334-0 Media and the Making of Social Class (1 Unit)**
The nature of the relationship between the media, middletown culture, and the rise of the American middle class; the future of middletown culture in the wake of digital production, audience segmentation, and globalization.

**COMM_ST 341-0 Communication and Aging (1 Unit)**
COMM_ST 344-0 Interpersonal Conflict (1 Unit)
In-depth analysis of theories and research examining conflict within relationships. Special emphasis on conflict within friendships, dating relationships, and family.
Prerequisite: COMM_ST 205-0.

COMM_ST 345-0 Family Communication (1 Unit)
An overview of the family as a communication system. Intergenerational interaction patterns, intimacy and conflict patterns, decision making, environmental and cultural factors, and enrichment efforts. A wide range of family types and research methods are considered.
Prerequisite: COMM_ST 241-0.

COMM_ST 351-0 Technology & Human Interaction (1 Unit)
Understanding human interactions that take place both with and through technology; design, creation, and evaluation of technologies to support such interactions.

COMM_ST 352-0 Social Network Analysis (1 Unit)
Use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales, ranging from small groups to the web. How we create social, economic, and technological networks; how these networks enable and constrain our attitudes and behavior.

COMM_ST 355-0 Audience Analysis (1 Unit)
Methods used to analyze electronic media audiences; emphasis on quantitative research techniques.
Prerequisites: COMM_ST 201-0 (or equivalent); COMM_ST 270-0.

COMM_ST 363-0 Bargaining and Negotiation (1 Unit)

COMM_ST 364-0 Collective Decision Making & Communication in Organizations (1 Unit)
Research on how organizations make, communicate, and implement collective decisions. Assessing decision effectiveness, group decision making, leadership in organizations, and organizational design.

COMM_ST 365-0 Solving Problems in Applied Organizational Communication (1 Unit)
Advanced concepts and techniques for defining and analyzing organizational problems. Preparation for recognizing and working with problems in business organizations.

COMM_ST 370-0 Ethnographies of Culture (1 Unit)
This course looks at ethnographies of artistic practice to better understand how culture is made, circulated, and received in social life.

COMM_ST 375-0 The Sociology of Online News (1 Unit)
Survey of sociological research on the production and consumption of online news.

COMM_ST 377-0 Development & Marketing Popular Culture (1 Unit)
The invention and packaging of popular culture products, including film, music, television, and celebrities.
Prerequisite: COMM_ST 275-0.

COMM_ST 378-0 Online Communities and Crowds (1 Unit)
Examination of the types of collaborations that occur in online communities and crowds. Emphasis on sociological, economic, and political analysis of how and why largescale online collaborations work.

COMM_ST 380-0 Political Communication (1 Unit)
Nature and functions of communication within established political institutions; decision making strategies, deliberative discourse, and electoral campaigns; field study of advocacy and interest groups.
Prerequisites: COMM_ST 220-0 and COMM_ST 205-0.

COMM_ST 385-0 Technology and the American Cultural Landscape (1 Unit)
Research seminar focusing on the history of technology in American culture and how it might affect our experience.

COMM_ST 386-0 Science, Technology, and Society (1 Unit)
Examination of developments in information and communication technology in the larger context of American science and technology since 1900.
Prerequisite: previous coursework on the historical or social dimensions of information and communication technology.

COMM_ST 388-0 Internet and Society (1 Unit)
The social, cultural, political, and economic implications of information technologies.

COMM_ST 389-0 Practicum in Communication Research (1 Unit)
Collaboration with a faculty member on design and execution of a communication research project. Students learn how to complete a research project and write a report.

COMM_ST 390-0 Children's Culture (1 Unit)
Examination of children's media from psychological, sociological, historical, and other perspectives. Discussion of the role of media in children's development.

COMM_ST 392-0 Global Culture, Commerce and Communication (1 Unit)
Examination of current topics and events to familiarize students with the cultural dimensions of globalization and the critical importance of culture and communication in understanding the globalized world.

COMM_ST 395-0 Topics in Communication Studies (1 Unit)
Reading, research, and discussion in areas of significance. Topics vary.

COMM_ST 400-0 Rhetoric and Public Culture Proseminar (1 Unit)
This course will aim to introduce students to key theories, vocabularies, and analytics used in the study of rhetoric and public culture.

COMM_ST 401-2 Approaches to Theory Development in Communication Inquiry (1 Unit)
First Quarter: Constructing scientific theories of human communication. Rule-governed approaches to the explanation of social behavior and implications for research methodology. Theory-development activities.
Second Quarter: Causal analysis and principles of research design in history and criticism; historical and critical evidence; relationships among science, history, and criticism.

COMM_ST 402-0 Modes of Cultural Analysis (1 Unit)
This class is designed to prepare students to engage in the cultural analysis of communicative forms, genres, and practices as situated in given contexts and historical moments. As such, it begins with the examination of some of the complex, even contradictory concepts of 'culture' that have been used to describe and analyze the constitution and consequences of communicative behavior. Drawing on political economy, critical cultural theory, and the literatures on identity, subjectivity, and community formation, this course introduces students to the challenges involved in connecting rhetoric and culture. Attention will be paid to British Cultural Studies, the Frankfurt School, and other significant discourses engaging with cultural theory.

COMM_ST 403-0 Intro to Methods of Mass Comm Research (1 Unit)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMM_ST 405-0</td>
<td>Seminar in Persuasion</td>
<td>1 Unit</td>
<td>Current developments and issues in persuasion; study of a particular issue or development. Prequisites: COMM_ST 401-2.</td>
</tr>
<tr>
<td>COMM_ST 407-0</td>
<td>Techniques &amp; Problems in Survey Research</td>
<td>1 Unit</td>
<td>Measurement theory, major sources of error in self-report, and techniques employed in survey research to reduce measurement error. Measurement problems associated with different modes of data collection, such as face-to-face or telephone interviews and self-administered questionnaires.</td>
</tr>
<tr>
<td>COMM_ST 412-0</td>
<td>Modern Rhetorical Theory</td>
<td>1 Unit</td>
<td>Studies of important theoretical problems, claims, and arguments in the modern era.</td>
</tr>
<tr>
<td>COMM_ST 414-0</td>
<td>Classical Rhetoric and Its Afterlives</td>
<td>1 Unit</td>
<td>Study of texts on rhetoric from Greek and Roman antiquity, with attention to subsequent histories, practices, and problems of appropriation.</td>
</tr>
<tr>
<td>COMM_ST 415-0</td>
<td>Seminar in Rhetorical Criticism</td>
<td>1 Unit</td>
<td>Elements of critical theory, methods of rhetorical criticism, and analysis and preparation of examples of rhetorical criticism.</td>
</tr>
<tr>
<td>COMM_ST 416-0</td>
<td>Contemporary Rhetorical Analysis</td>
<td>1 Unit</td>
<td>Study of recent controversies, discourses, genres, or media.</td>
</tr>
<tr>
<td>COMM_ST 417-0</td>
<td>Rhettoric and Social Theory</td>
<td>1 Unit</td>
<td>Major assumptions in European social theory and their implications for rhetorical theory and practice.</td>
</tr>
<tr>
<td>COMM_ST 420-0</td>
<td>Seminar in Argumentation</td>
<td>1 Unit</td>
<td>Topics related to the processes by which people justify their acts, beliefs, attitudes, and values and influence the thought and action of others.</td>
</tr>
<tr>
<td>COMM_ST 425-0</td>
<td>Seminar-Problems in Comm Studies</td>
<td>1 Unit</td>
<td>Study of specific theoretical, methodological, or practical problems in communication.</td>
</tr>
<tr>
<td>COMM_ST 440-0</td>
<td>Seminar in Interpersonal Communication</td>
<td>1 Unit</td>
<td>Topics related to communication in informal, unstructured settings. Prequisites: Permission of instructor.</td>
</tr>
<tr>
<td>COMM_ST 450-0</td>
<td>Seminar in Small Group Processes</td>
<td>1 Unit</td>
<td>Topics related to communication in small groups. Prequisites: Permission of instructor.</td>
</tr>
<tr>
<td>COMM_ST 453-0</td>
<td>Visual Rhetoric</td>
<td>1 Unit</td>
<td>Study of the use of visual images to shape public identity, thought, and action, with particular emphasis on the public art of photojournalism.</td>
</tr>
<tr>
<td>COMM_ST 455-0</td>
<td>Current Issues in Audience Studies</td>
<td>1 Unit</td>
<td>Focuses on current research and theory about media audiences. Special attention is paid to television audience behavior, theories of exposure, models of program choice, the use of audiences as commodities, and how audiences experience the media.</td>
</tr>
<tr>
<td>COMM_ST 465-0</td>
<td>The Research Literature of Organizational Communication</td>
<td>1 Unit</td>
<td>Major viewpoints and theoretical contributions to the research literature on communication behavior in organizational, institutional, and social system contexts.</td>
</tr>
<tr>
<td>COMM_ST 471-0</td>
<td>Intellectual Foundations of Mass Communication Research</td>
<td>1 Unit</td>
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<tr>
<td>COMM_ST 475-0</td>
<td>Seminar in the Rhetoric of Contemp Cult</td>
<td>1 Unit</td>
<td>Strategies of influence in contemporary culture; field studies.</td>
</tr>
<tr>
<td>COMM_ST 484-0</td>
<td>Mind and Society in the Information Age</td>
<td>1 Unit</td>
<td>Examines the historical origins as well as the psychological, social, and cultural consequences of the technologies and industries that are powering the “information revolution.” Prequisites: Permission of instructor required.</td>
</tr>
<tr>
<td>COMM_ST 487-0</td>
<td>Legal and Political Dimensions of Telecommunications</td>
<td>1 Unit</td>
<td>A study of legal and regulatory processes affecting mass media and common carrier (voice and data transmission) communications industries. Examines specific laws and regulations and the policy-making process.</td>
</tr>
<tr>
<td>COMM_ST 488-0</td>
<td>Topics in the History of Information and Communication Technology</td>
<td>1 Unit</td>
<td>Examination of developments in information and communication technology in the larger context of American science and technology since 1900.</td>
</tr>
<tr>
<td>COMM_ST 499-0</td>
<td>Independent Study</td>
<td>1-2 Units</td>
<td>Permission of instructor and department required. May be repeated for credit.</td>
</tr>
<tr>
<td>COMP_LIT 311-0</td>
<td>Theory and Practice of Translation</td>
<td>1 Unit</td>
<td>Introduction to theoretical approaches to literary translation and to the practice of poetry translation.</td>
</tr>
<tr>
<td>COMP_LIT 410-0</td>
<td>Theories of Literature</td>
<td>1 Unit</td>
<td>The aim of this sequence (COMP_LIT 410-0; COMP_LIT 411-0; COMP_LIT 412-0), respectively taught in the Fall, Winter and Spring quarters of the first year by different instructors, is to offer an intensive analysis of several major philosophical and literary texts in order to prepare the students for their first-year examination. Content varies and each year the focus changes. It will be possible for students to retake the class.</td>
</tr>
</tbody>
</table>
COMP_ENG 303-0 Advanced Digital Design (1 Unit)

COMP_ENG 355-0 ASIC and FPGA Design (1 Unit)
Prerequisite: COMP_ENG 303-0.

Overview of digital logic design. Technology review. Delays, timing in combinational and sequential circuits, CAD tools, arithmetic units such as ALUs and multipliers. Introduction to VHDL.

Prerequisite: COMP_ENG 203-0.

COMP_ENG 356-0 Introduction to Formal Specification & Verification (1 Unit)
Prerequisite: COMP_ENG 203-0.

COMP_ENG 357-0 Design Automation in VLSI (1 Unit)
Prerequisite: COMP_SCI 110-0 or COMP_SCI 111-0.

COMP_ENG 358-0 Introduction to Parallel Computing (1 Unit)
Prerequisite: COMP_SCI 214-0, COMP_ENG 303-0.

COMP_LIT 401-0 Critical Practices (1 Unit)
The aim of this sequence (COMP_LIT 410-0; COMP_LIT 411-0; COMP_LIT 412-0), respectively taught in the Fall, Winter and Spring quarters of the first year by different instructors, is to offer an intensive analysis of several major philosophical and literary texts in order to prepare the students for their first-year examination. Content varies and each year the focus changes. It will be possible for students to retake the class.

COMP_LIT 410-0 Literature Studies Colloquium (1 Unit)
The aim of this sequence (COMP_LIT 410-0; COMP_LIT 411-0; COMP_LIT 412-0), respectively taught in the Fall, Winter and Spring quarters of the first year by different instructors, is to offer an intensive analysis of several major philosophical and literary texts in order to prepare the students for their first-year examination. Content varies and each year the focus changes. It will be possible for students to retake the class.

COMP_LIT 412-0 Literary Studies Colloquium (1 Unit)
Use and variation of a literary theme (such as the journey) or technique (such as symbolism and allegory) in various times and cultures.

COMP_LIT 414-0 Comparative Studies in Genre (1 Unit)
Theory and practice of a literary genre (such as epic, tragedy, or the novel) in various times and cultures.

COMP_LIT 413-0 Comparative Studies in Theme (1 Unit)
Use and variation of a literary theme (such as the journey) or technique (such as symbolism and allegory) in various times and cultures.

COMP_LIT 481-0 Studies in Literary Theory (1 Unit)
Central issues of criticism, exemplified by the writings of major theorists.

COMP_LIT 482-0 Studies in Literature & the Disciplines (1 Unit)
Topics in the encounter between literary studies and other culturally oriented disciplines (e.g., philosophy, history, and anthropology) with an emphasis on problems of theory and method. Content varies.

COMP_LIT 487-0 Studies in Literature and the Arts (1 Unit)
The relation between literature and the visual arts and/or music. Content varies.

COMP_LIT 488-0 Special Topics in Comparative Literature (1 Unit)
Doctoral-level course offered on a one-time basis dealing with a special topic in the field of comparative literature. Addresses a specific need within the program's curriculum and/or a trend in the field.

COMP_LIT 490-0 Independent Reading (1 Unit)
This course is used for teaching experience.

COMP_LIT 499-0 Independent Study (1 Unit)
Permission of instructor and department required. May be repeated for credit.

COMP_LIT 590-0 Research (1-3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation.

COMP_LIT 596-0 Phd Thesis Tutorial (1 Unit)
Production of a dissertation prospectus, including a statement of purpose and critical method, an outline, and bibliography. May only be taken in the third year in the quarter prior to admission to candidacy.

Comparative Race and Diaspora (CRD)

CRD 410-0 Introduction to Comparative Race and Diaspora (1 Unit)

Computer Engineering (COMP_ENG)

COMP_ENG 303-0 Advanced Digital Design (1 Unit)
(e.g., ALU); control design; single cycle, multiple cycle, and pipeline implementations of processor. Hazard detection and forwarding; memory hierarchy design; cache memories, virtual memory, peripheral devices, and I/O.
Prerequisites: (COMP_ENG 205-0 or COMP_SCI 213-0) AND (COMP_ENG 303-0 or COMP_ENG 355-0).

COMP_ENG 362-0 Computer Architecture Projects (1 Unit)
Quarter-long team project designing a processor for a complete instruction set. Involves ISA design, design of components, data-path, and control for a pipelined processor to implement the ISA. Use of industrial-strength design tools and VHDL as the design specification language. Designs are evaluated using benchmark programs for correctness and performance.
Prerequisite: COMP_ENG 361-0.

COMP_ENG 368-0 Programming Massively Parallel Processors with CUDA (1 Unit)
A hands-on introduction to parallel programming and optimizations for 1000+ core GPU processors, their architecture, the CUDA programming model, and performance analysis. Students implement various optimizations in massively-parallel workloads on modern GPUs. May not receive credit for both COMP_ENG 368-0 and COMP_ENG 468-0.
Prerequisites: (COMP_SCI 213-0 and (COMP_SCI 211-0 or COMP_SCI 230-0)) or permission of instructor.

COMP_ENG 391-0 CMOS VLSI Circuit Design (1 Unit)
Design of modern CMOS very large-scale integrated (VLSI) circuits.

COMP_ENG 392-0 VLSI Systems Design Projects (1 Unit)
Quarter-long team project designing a processor for a complete instruction set. Involves ISA design, design of components, data-path, and control for a pipelined processor to implement the ISA. Use of industrial-strength design tools and VHDL as the design specification language. Designs are evaluated using benchmark programs for correctness and performance.
Prerequisite: COMP_ENG 361-0.

COMP_ENG 393-0 Advanced Low Power VLSI and Mixed-signal IC Design (1 Unit)
This course provides an in-depth review of the advanced technology in integrated circuit design. Special focuses will be given to ultra-low power circuit design, error resilient circuit design, machine learning accelerators, power management circuits and basic design of analog mixed-signal circuit. Following a seminar format, detailed case study on circuit design techniques used by Intel, IBM, etc. will be discussed.

COMP_ENG 395-0 Special Topics in Computer Engineering (1 Unit)
Topics suggested by students or faculty and approved by the department.

COMP_ENG 420-0 Adv Computer Architecture (1 Unit)
Design and evaluation of modern uniprocessor computing systems. Evaluation of methodology/metrics and caveats, instruction set design, advanced pipelining, instruction level parallelism, prediction-based techniques, alternative architectures (VLIW, Vector and SIMD), memory hierarchy design and I/O. Case studies.
Prerequisites: COMP_ENG 361-0.

COMP_ENG 452-0 Parallel Architectures (1 Unit)
Parallel computer architecture and programming models. Design issues for shared memory multiprocessors including scalability, synchronization, memory consistency, and cache coherence. Memory hierarchy and on-chip network design.
Prerequisites: COMP_ENG 361-0 or permission of instructor.

COMP_ENG 453-0 Special Topics in Computer Engineering (1 Unit)
The course will introduce trends and challenges of modern cyberphysical systems, and review state-of-the-art design paradigms and tools in academia and industry. It will introduce fundamental concepts in the modeling of cyber-physical systems, important models of computation such as dataflow, state machine, and synchronous-reactive semantics, real-time embedded architectures, and synthesis methodologies for generating efficient, correct, and predictable implementations.

COMP_ENG 456-0 Modern Topics in Computer Architecture (1 Unit)
Covers advanced contemporary topics in computer architecture. Content is drawn from recent and seminal publications across a wide range of topics, including quantum and neuromorphic computing, space-time computing, silicon photonics in computer architectures, advanced memory systems, energy and power efficiency. Topics vary across offerings as the field evolves.
Prerequisites: COMP_ENG 361-0 or permission of instructor.

COMP_ENG 459-0 VLSI Algorithms (1 Unit)
Design and analysis of algorithms for VLSI synthesis problems. Study both theoretical and practical aspects of CAD-tool development in VLSI environments.
Prerequisites: COMP_SCI 336-0.

COMP_ENG 464-0 Cyber-Physical Systems Design and Application (1 Unit)
In-depth review of advanced technology surrounding the Internet-of-Things; including wireless sensing networks, wearables, drones, privacy, machine learning, and energy-efficient computing. Application domains in health, infrastructure monitoring, green computing and others are explored. Following a seminar format with alongside exploration of new research areas through a project proposal.

COMP_ENG 465-0 Internet-of-things Sensors, Systems, And Applications (1 Unit)
In-depth review of advanced technology surrounding the Internet-of-Things; including wireless sensing networks, wearables, drones, privacy, machine learning, and energy-efficient computing. Application domains in health, infrastructure monitoring, green computing and others are explored. Following a seminar format with alongside exploration of new research areas through a project proposal.

COMP_ENG 466-0 Embedded Systems (1 Unit)
Introduction to the design and evaluation of embedded systems, with emphasis on the system-level aspects of embedded systems. Topics include modeling (models of computation and models of communication), survey of embedded system hardware, software and operating system issues specific to embedded system design, mapping specifications to hardware, and testing and evaluation of embedded systems.
Prerequisites: Senior or graduate standing in Computer Science or Computer Engineering.

COMP_ENG 468-0 Programming Massively Parallel Processors with CUDA (1 Unit)
A hands-on introduction to parallel programming and optimizations for 1000+ core processors (GPGPUs), their architecture, the CUDA programming model, and performance analysis. Students implement various optimizations on massively-parallel workloads on modern GPUs. Requires quarter-long parallel programming project using CUDA. May not receive credit for both COMP_ENG 368-0 and COMP_ENG 468-0.
Prerequisites: (COMP_SCI 213-0 and (COMP_SCI 211-0 or COMP_SCI 230-0)) or permission of instructor.

COMP_ENG 493-0 Advanced Low Power VLSI and Mixed-signal IC Design (1 Unit)
This course provides an in-depth review of the advanced technology in integrated circuit design. Special focuses will be given to ultra-low power circuit design, error resilient circuit design, machine learning accelerators, power management circuits and basic design of analog mixed-signal circuit. Following a seminar format, detailed case study on circuit design techniques used by Intel, IBM, etc. will be discussed.

COMP_ENG 495-0 Special Topics in Computer Engineering (1 Unit)
COMP_ENG 499-0 Projects (1 Unit)
Special projects carried out under faculty direction. Permission of instructor and department required.

COMP_ENG 510-0 Seminar (1 Unit)
Seminar on topics of current interest.

COMP_ENG 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**Computer Science (COMP_SCI)**

COMP_SCI 314-0 Technology and Human Interaction (1 Unit)
Understanding human interactions that occur both with and through technology; design, creation, and evaluation of technologies to support such interactions.

COMP_SCI 315-0 Design, Technology, and Research (1 Unit)
Hands-on experience in the research learning environment. Students lead research projects in social and crowd computing, cyber-learning, human-computer interaction, and artificial intelligence. Prerequisite: consent of instructor (by application only).

COMP_SCI 321-0 Programming Languages (1 Unit)
Introduction to key parts of programming languages: syntax, semantics, and pragmatics. Implementation of a series of interpreters that show how various aspects of programming languages behave. Prerequisite: COMP_SCI 111-0, COMP_SCI 214-0.

COMP_SCI 322-0 Compiler Construction (1 Unit)
The compiler is the programmer's primary tool. Understanding the compiler is therefore critical for programmers, even if they never build one. Furthermore, many design techniques that emerged in the context of compilers are useful for a range of other application areas. This course introduces students to the essential elements of building a compiler: parsing, context-sensitive property checking, code linearization, register allocation, etc. To take this course, students are expected to already understand how programming languages behave, to a fairly detailed degree. The material in the course builds on that knowledge via a series of semantics preserving transformations that start with a fairly high-level programming language and culminate in machine code. Prerequisite: COMP_SCI 213-0.

COMP_SCI 323-0 Code Analysis and Transformation (1 Unit)
Fast, highly sophisticated code analysis and code transformation tools are essential for modern software development. Before releasing its mobile apps, Facebook submits them to a tool called Infer that finds bugs by static analysis, i.e., without even having to run the code, and guides developers in fixing them. Google Chrome and Mozilla Firefox analyze and optimize JavaScript code to make browsers acceptably responsive. Performance-critical systems and application software would be impossible to build and evolve without compilers that derive highly optimized machine code from high-level source code that humans can understand. Understanding what modern code analysis and transformation techniques can and can’t do is a prerequisite for research on both software engineering and computer architecture since hardware relies on software to realize its potential. In this class, you will learn the fundamentals of code analysis and transformation, and you will apply them by extending LLVM, a compiler framework now in production use by Apple, Adobe, Intel and other industrial and academic enterprises. Prerequisite: COMP_SCI 213-0.

COMP_SCI 325-1 Artificial Intelligence Programming (1 Unit)
Introduction to LISP and programming knowledge-based systems and interfaces. Strong emphasis on writing maintainable, extensible systems.

Topics include semantic net-works, frames, pattern matching, deductive inference rules, case-based reasoning, and discrimination trees. Project-driven. Substantial programming assignments. Prerequisite: COMP_SCI 110-0, COMP_SCI 111-0, or programming experience.

COMP_SCI 330-0 Human Computer Interaction (1 Unit)
Introduction to human-computer interaction and design of systems that work for people and their organizations. Understanding the manner in which humans interact with and use computers for productive work. Prerequisite: programming experience.

COMP_SCI 331-0 Introduction to Computational Photography (1 Unit)
Fundamentals of digital imaging and modern camera architectures. Hands-on experience acquiring, characterizing, and manipulating data captured using a modern camera platform.

COMP_SCI 335-0 Introduction to the Theory of Computation (1 Unit)
Mathematical foundations of computation, including computability, relationships of time and space, and the P vs. NP problem. Prerequisite: COMP_SCI 212-0 or consent of instructor.

COMP_SCI 336-0 Design & Analysis of Algorithms (1 Unit)
Analysis techniques: solving recurrence equations. Algorithm design techniques: divide and conquer, the greedy method, backtracking, branch-and-bound, and dynamic programming. Sorting and selection algorithms, order statistics, heaps, and priority queues. Prerequisite: COMP_SCI 111-0, COMP_SCI 212-0, or consent of instructor.

COMP_SCI 337-0 Natural Language Processing (1 Unit)
Semantics-oriented introduction to natural language processing, broadly construed. Representation of meaning and knowledge inference in story understanding, script/frame theory, plans and plan recognition, counter-planning, and thematic structures. Prerequisite: COMP_SCI 348-0 or consent of instructor.

COMP_SCI 338-0 Practicum in Intelligent Information Systems (1 Unit)
A practical excursion into building intelligent information systems. Students develop a working program in information access, management, capture, or retrieval. Project definition, data collection, technology selection, implementation, and project management.

COMP_SCI 339-0 Introduction to Database Systems (1 Unit)
Data models and database design. Modeling the real world: structures, constraints, and operations. The entity relationship to data modeling (including network hierarchical and object-oriented), emphasis on the relational model. Use of existing database systems for the implementation of information systems. Prerequisites: COMP_SCI 214-0 and (COMP_SCI 213-0 or COMP_ENG 205-0).

COMP_SCI 340-0 Introduction to Networking (1 Unit)
A top-down exploration of networking using the five-layer model and the TCP/IP stack, covering each layer in depth. Students build web clients, servers, and a TCP implementation and implement routing algorithms. Prerequisites: COMP_SCI 214-0 and (COMP_SCI 213-0 or COMP_ENG 205-0).

COMP_SCI 341-0 Mechanism Design (1 Unit)
Applying algorithms and microeconomics to derive a theory of the design of mechanisms that produce desired outcomes despite counteractive inputs by outside agents. Key application areas: auctions, markets, networking protocols.

COMP_SCI 343-0 Operating Systems (1 Unit)
Fundamental overview of operating systems, including: concurrency (processes, synchronization, semaphores, monitors, deadlock); memory management (segmentation, paging virtual memory policies); software
system architectures (level structures, microkernels); file systems (directory structures, file organization, RAID); protection (access control, capabilities, encryption, signatures, authentication). Requires substantial programming projects.
Prerequisites: Both COMP_SCI 214-0 and COMP_SCI 213-0, or COMP_SCI 214-0 and COMP_ENG 205-0.

COMP_SCI 344-0 Design of Computer Problem Solvers (1 Unit)
Principles and practice of organizing and building artificial intelligence reasoning systems. Pattern-directed rule systems, truth-maintenance systems, and constraint languages.
Prerequisites: COMP_SCI 348-0 and COMP_SCI 325-1 or equivalent LISP experience.

COMP_SCI 345-0 Distributed Systems (1 Unit)
Basic principles behind distributed systems (collections of independent components that appear to users as a single coherent system) and main paradigms used to organize them.
Prerequisites: COMP_SCI 213-0 and COMP_SCI 214-0.

COMP_SCI 348-0 Introduction to Artificial Intelligence (1 Unit)

COMP_SCI 349-0 Machine Learning (1 Unit)
Study of algorithms that improve through experience. Topics typically include Bayesian learning, decision trees, genetic algorithms, neural networks, Markov models, and reinforcement learning. Assignments include programming projects and written work.
Prerequisite: COMP_SCI 348-0.

COMP_SCI 350-0 Introduction to Computer Security (1 Unit)
Basic principles and practices of computer and information security. Software, operating system, and network security techniques, with detailed analysis of real-world examples. Topics include cryptography, authentication, software and operating system security (e.g., buffer overflow), Internet vulnerability (DoS attacks, viruses/worms, etc.), intrusion detection systems, firewalls, VPN, and web and wireless security.
Prerequisite: COMP_SCI 213-0 or equivalent consent of instructor; COMP_SCI 340-0 highly recommended.

COMP_SCI 351-1 Introduction to Computer Graphics (1 Unit)
Mathematical software and hardware requirements for computer graphics systems. Data structures and programming languages. Random displays. Graphic applications.
Prerequisite: COMP_SCI 214-0.

COMP_SCI 351-2 Intermediate Computer Graphics (1 Unit)
Methods and theory of computer graphics. Project-oriented approach. Describing shapes, movement, and lighting effects; interactive elements.
Prerequisites: COMP_SCI 214-0 and COMP_SCI 351-1.

COMP_SCI 352-0 Machine Perception of Music & Audio (1 Unit)
Machine extraction of musical structure in audio and MIDI and score files, covering areas such as source separation and perceptual mapping of audio to machine-quantifiable measures.
Prerequisite: COMP_SCI 211-0, GEN_ENG 205-2, or prior programming experience in MATLAB.

COMP_SCI 354-0 Network Penetration & Security (1 Unit)
Practical tools for vulnerability assessment and defense of computer and communication systems.
Prerequisites: COMP_SCI 213-0 or COMP_ENG 205-0; ELEC_ENG 333-0 or COMP_SCI 340-0.

COMP_SCI 367-0 Wireless and Mobile Health: Passive Sensing Data Analytics (1 Unit)
A hands-on introduction and experience to the growing field of mobile Health. Students work together on a project with clinicians and faculty in medicine, building a unique mHealth system while testing their system on a small population. Theory-driven project hypothesis, technology selection and development, passive sensing data analytic chain understanding and implementation, and project management.

COMP_SCI 370-0 Computer Game Design (1 Unit)
Plot, narrative, and character simulation for creating game worlds; artificial intelligence for synthetic characters; tuning gameplay. Substantial programming and project work.
Prerequisites: COMP_SCI 214-0; 1 unit of COMP_SCI 322-0, COMP_SCI 343-0, COMP_SCI 348-0, or COMP_SCI 351-1, COMP_SCI 351-2.

COMP_SCI 371-0 Knowledge Representation and Reasoning (1 Unit)
Principles and practices of knowledge representation, including logics, ontologies, commonsense knowledge, and semantic web technologies.
Prerequisite: COMP_SCI 348-0, COMP_SCI 325-1, or equivalent experience with artificial intelligence.

COMP_SCI 376-0 Computer Game Design and Development (1 Unit)
Introduction to design of simulation-based media, with an emphasis on 2D game design. Mathematical preliminaries: linear, affine, and projective spaces, linear transforms, inner and exterior products, unit quaternions; Architecture: update/render loop, component systems, serialization and deserialization, event handling and asynchronous processing, multitasking; Rendering: scene graphs, meshes, shaders, sprites; Networking; Audio; Physics: particles, rigid bodies, collision detection; Gameplay design.
Prerequisite: COMP_SCI 214-0.

COMP_SCI 377-0 Game Design Studio (1 Unit)
In this course, students will design and develop games using the Unity game engine, with focus on team-based projects and agile development practices. Lectures will cover game design theory, game architecture and implementation, and the business of game development. Students will participate in class discussion and evaluation of projects in progress, to develop their skills in iterative design and implementation.
Prerequisite: COMP_SCI 376-0.

COMP_SCI 378-0 Software Construction (1 Unit)
Building software is a craft that requires careful design. This course teaches software design principles in a studio setting. Each week, students present their programs to the class for review. Together, the class evaluates the programs for correctness and, more importantly, clarity and design. Expect to learn how to build reliable, maintainable, extensible software and how to read others’ codes.
Prerequisites: COMP_SCI 111-0 and COMP_SCI 214-0.

COMP_SCI 394-0 Agile Software Development (1 Unit)
Developing mobile and web applications, using modern sustainable agile practices, such as backlogs, user stories, velocity charts, and test driven development, to deliver value as quickly as possible to end users, clients, developers, and the development organization.

COMP_SCI 396-0 Special Topics in Computer Science (1 Unit)
Projects suggested by faculty and approved by the department. Equivalent to 397 but intended to apply toward courses for the computer science major and its project requirement.

COMP_SCI 397-0 Special Projects in Computer Science (1 Unit)
COMP_SCI 413-0 Tangible Interaction Design and Learning (1 Unit)
Explores the use of tangible interaction to create innovative learning experiences, including distributed cognition, embodied interaction, cultural forms, and design frameworks.
Prerequisite: COMP_SCI 110-0 or COMP_SCI 111-0

COMP_SCI 430-0 Design of Interactive Learning Environments (1 Unit)
Design of computer-based "learning-by-doing" environments. Course focuses more on initial conception of learning environments than on technical issues involved in building these environments.

COMP_SCI 431-0 Human Perception and Electronic Media (1 Unit)

COMP_SCI 440-0 Advanced Networking (1 Unit)
This course will cover a broad range of topics including Internet evolution and architectures; analysis and design of network protocols (both wired and wireless); networking issues for Web and gaming applications; analysis and performance of content distribution networks; network security, vulnerability, and defenses.
Prerequisites: COMP_SCI 340-0 or permission of instructor.

COMP_SCI 441-0 Resource Virtualization (1 Unit)
The bulk of the time in this class examining a virtual machine monitor (VMM) in depth, at the source code level. The course explains the hardware/software interface of a modern x86 computer in detail. A VMM is an operating system that is implemented directly on top of the hardware interface, and itself presents a hardware interface to higher-level software. Students will also acquire valuable kernel development skills.
Prerequisites: COMP_SCI 213-0.

COMP_SCI 443-0 Advanced Operating Systems (1 Unit)
Advanced concepts in operating systems and distributed computing from historical perspectives to current themes such as peer-to-peer computing and mobile systems.

COMP_SCI 445-0 Internet-scale Experimentation (1 Unit)
Explores the challenges of large-scale networked system experimentation and measurement.

COMP_SCI 446-0 Kernel and Other Low-level Software Development (1 Unit)
The development of low-level systems software such as drivers, kernels, etc is very different from the development of applications. This class teaches how such development is done: how to design, implement, debug, and optimize low-level software and use available tools.
Prerequisites: COMP_SCI 213-0 or COMP.ENG 205-0) and (COMP_SCI 343-0 or COMP.ENG 361-0 or COMP.ENG 366-0 or COMP.ENG 466-0) or permission of Instructor.

COMP_SCI 450-0 Internet Security (1 Unit)
Through measurement-based approaches, students analyze the complexity of the Internet, and develop countermeasures against various vulnerabilities of the Internet such as viruses, worms, and denial of service attacks.

COMP_SCI 455-0 Distributed Computing Systems (1 Unit)
Fundamentals and systems design aspects of distributed systems, paradigms for distributed computing, client-server computing, concurrency control, distributed file systems, resource management, high-performance computing aspects.
Prerequisites: COMP_SCI 343-0 or COMP.ENG 361-0.

COMP_SCI 457-0 Advanced Algorithms (1 Unit)
Analysis and design of algorithms; amortized analysis; arithmetic circuits; computational geometry; NP-completeness; approximation algorithms.
Prerequisites: COMP_SCI 336-0 or any algorithms course.

COMP_SCI 469-0 Machine Learning & Artificial Intelligence for Robotics (1 Unit)
A coverage of artificial intelligence, machine learning and statistical estimation topics that are especially relevant for robot operation and robotics research. Prerequisite: Graduate-level standing (or permission of instructor) for the maths. Some programming experience (in Matlab okay). Undergraduate student enrollment by permission of instructor only.

COMP_SCI 472-0 Designing & Constructing Models with Multi-Agent Language (1 Unit)

COMP_SCI 473-1 NUvention: Web - Part 1 (1 Unit)
NUvention: Web is an interdisciplinary experiential learning program designed to expose students to the entire product and business development life cycle for a software company.

COMP_SCI 473-2 NUvention: Web - Part 2 (1 Unit)
NUvention: Web is an interdisciplinary experiential learning program designed to expose students to the entire product and business development life cycle for a software company.

COMP_SCI 474-0 Probabilistic Graphical Models (1 Unit)
Probabilistic graphical models are a powerful technique for handling uncertainty in machine learning. The course will cover how probability distributions can be represented in graphical models, how inference and learning are performed in the models, and how the models are utilized for machine learning in practice.

COMP_SCI 496-0 Special Topics in Computer Science (1 Unit)
Topics suggested by faculty and approved by the department.

COMP_SCI 497-0 Special Projects in Computer Science (1 Unit)
Project-based course on topics suggested by faculty and approved by the department.

COMP_SCI 499-0 Projects (1 Unit)
Special projects carried out under faculty direction. Permission of instructor and department required.

COMP_SCI 510-0 Seminar (1 Unit)
Seminars on topics of current interest.

COMP_SCI 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Counseling (COUN)

COUN 406-0 Research Methods in Counseling (1 Unit)
The course promotes counselors as producers and consumers of published research. It will explore research types and methods, basic statistics, and ethical considerations in conducting studies. The course will also explore principles, practices of needs assessment and program evaluation. Assignments will offer students opportunities to apply knowledge and skills gained in class.

COUN 406-0 Research Methods in Counseling (1 Unit)
The course promotes counselors as producers and consumers of published research. The course will explore research types and methods, basic statistics, and ethical considerations in conducting studies. The course will also explore principles, practices of needs assessment and program evaluation. Assignments will offer students
opportunities to apply knowledge and skills gained in class. Requirement: Counseling@Northwestern Students Only.

COUN 411-0 Individuals & Systems: Psychodynamic Viewpoints (1 Unit)
Psychodynamic theories of personality and social systems. Application to analysis of interpersonal and helping relationships; personality development and dynamics; psychopathology, assessment, and intervention in relation to individuals and organizations.

COUN 411-6 Psychodynamic Counseling (Onground: Individuals and Systems (1 Unit)
This course is designed to serve as a clinical and theoretical foundation for the practice of psychodynamic counseling. It emphasizes application to analysis of interpersonal and helping relationships; personality development and dynamics; psychopathology, assessment, and intervention. Requirement: Counseling@Northwestern Students Only.

COUN 412-0 Theories & Techniques of Group dynamics (1 Unit)
This course focuses on group dynamics. Emphases include applying theories and techniques to actual group situations in a variety of settings and increased self-awareness by way of a required weekend group immersion experience (Tavistock) that will highlight psychodynamic elements of groupwork.

COUN 412-6 Theories & Techniques of Group Dynamics (1 Unit)
This course focuses on group dynamics. Emphases include applying theories and techniques to actual group situations in a variety of settings and increased self-awareness by way of a required weekend group immersion experience that will highlight psychodynamic elements of groupwork. Requirement: Counseling@Northwestern Students Only.

COUN 413-6 Human Development (Child) (1 Unit)
This course explores the nature and needs of individuals at developmental levels throughout the lifespan and in a multicultural context with implications for assessment, intervention, and prevention strategies. The course has an additional focus on children and adolescents. Requirement: Counseling@Northwestern Students Only.

COUN 414-0 Human Growth and Development (1 Unit)
This course explores the nature and needs of individuals at developmental levels throughout the lifespan and in a multicultural context with implications for assessment, intervention, and prevention strategies. The course has an additional focus on children and adolescents.

COUN 414-6 Human Development (Adult) (1 Unit)
This course provides an understanding of the nature and needs of persons at all developmental levels and in a multicultural context. Implications for assessment and preventive and/or supportive intervention strategies. This course has an additional specific focus on adult development. Requirement: Counseling@Northwestern Students Only.

COUN 415-0 Psychopathology in Counseling (1 Unit)
This course explores the adaptive, pathological, individual, and family functioning through the life course. Developmental vulnerabilities, transitions, and tasks from a psychodynamic perspective. Emphasis is on development of diagnosis skills using the DSM or ICD formulations.

COUN 415-6 Psychopathology in Counseling (1 Unit)
This course explores the adaptive, pathological, individual, and family functioning through the life course. Developmental vulnerabilities, transitions, and tasks from a psychodynamic perspective. Emphasis is on development of diagnosis skills using the DSM or ICD formulations. Application will link diagnostic information to current events. Clinical, developmental, and family systems research; onset and dynamics of common psychiatric disorders. Requirement: Counseling@Northwestern Students Only.

COUN 416-0 Theories of Counseling & Psychotherapy (1 Unit)
This course provides an in-depth examination of the basic theoretical frameworks that inform the practice of counseling and psychotherapy.

COUN 416-6 Theories of Counseling & Psychotherapy (1 Unit)
This course provides an in-depth examination of the basic theoretical frameworks that inform the practice of counseling and psychotherapy. Requirement: Counseling@Northwestern Students Only.

COUN 417-0 Cognitive Behavioral Therapy (1 Unit)
This course will provide an overview of current cognitive behavioral treatment approaches to common adult disorders. Although the research literature is covered, the emphasis is on clinical practice. Lectures, group discussion, role-plays, student presentations, a final exam, and an optional paper will be used for application activities.

COUN 417-6 Cognitive Behavioral Therapy (1 Unit)
This course will provide an overview of current cognitive behavioral treatment approaches to common adult disorders. Although the research literature is covered, the emphasis is on clinical practice. Lectures, group discussion, role-plays, student presentations, a final exam, and an optional paper for application activities will be used in this course. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 413-6 or COUN 414-6 Human Development

COUN 418-0 Psychodynamic Counseling (1 Unit)
This course explores basic psychological concepts and theories useful in understanding individual and couple processes and therapies from a psychodynamic/systems point of view. Psycho-dynamically oriented individual, couples, and group psychotherapy are emphasized.

COUN 419-0 Contemporary Issues in Career Counseling (1 Unit)
This course explores training and employment transitions for youth and adults. It emphasizes improving design and delivery of service, career, and labor market information; placement at the local-community and individual-client levels.

COUN 422-0 Foundations of Family, Marital and Couples Counseling (1 Unit)
This course is an introduction to theories and practices of family, marital and couple therapy. The course will examine a) the evolution and foundations of systems; b) classic and contemporary family, marital and couple therapy approaches; c) the impact of cultural/social trends on family and couple life and d) how systems perspectives can be incorporated into the work of one client.

COUN 422-6 Foundations of Family, Marital and Couples Counseling (1 Unit)
This course is an introduction to theories and practices of family, marital and couple therapy. The course will examine a) the evolution and foundations of systems; b) classic and contemporary family, marital and couple therapy approaches; c) the impact of cultural/social trends on family and couple life and d) how systems perspectives can be incorporated into the work of one client. Requirement: Counseling@Northwestern Students Only.

COUN 425-0 Improving Methods and Practices in Psychological Science: The Replication Crisis and Beyond (1 Unit)
This course will examine current controversies and new developments in research methods in psychology. The goal of the course is to learn to think critically about how psychological science is conducted and how conclusions are drawn. We will cover both methodological and statistical
issues that affect the validity of research in psychology, with a scope that will cover the broad topical range of psychological science. We will discuss the research process from designing a study to how a study gets published. We will also discuss the recent controversy in psychology about the replicability of scientific results.

**COUN 426-0 Assessment in Counseling (1 Unit)**
This course provides an understanding of individual approaches to assessment in a multicultural society across the lifespan. Review of commonly used assessments in counseling including rationale, characteristics, administration, and interpretation.

**COUN 426-6 Assessment in Counseling (1 Unit)**
This course provides an understanding of individual approaches to assessment in a multicultural society across the lifespan. Review of commonly used assessments in counseling including rationale, characteristics, administration, and interpretation. Requirement: Counseling@Northwestern Students Only.

**COUN 427-0 Career Development (1 Unit)**
This course explores theories of career choice, career commitment, and life-course development applied to research and practice in career counseling.

**COUN 427-6 Career Development (1 Unit)**
This course explores theories of career choice, career commitment, and life-course development applied to research and practice in career counseling. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 426-6 Assessment in Counseling

**COUN 429-6 Sexuality in Counseling (1 Unit)**
This course offers a multidimensional, biophysical approach to the diagnosis and treatment of sexual difficulty in individuals and couples. Including disorders of desire, aversion, arousal, orgasm, and pain. Requirement: Counseling@Northwestern Students Only.

**COUN 430-0 Vocational Assessment in Counseling (1 Unit)**
Major measures of career development, vocational interests, and occupational aptitudes. Principles and practice in developing vocational appraisals.

**COUN 436-0 COUN 436-0 Child & Adolescent Counseling and Psychotherapy (1 Unit) (1 Unit)**
This course examines central issues in child and adolescent psychotherapy and the mainstream treatment approaches including psychoanalytic, play, cognitive-behavioral and behavioral therapy. Emphasis on high-frequency problems for which children/adolescent enter therapy.

**COUN 436-6 Child & Adolescent Counseling and Psychotherapy (1 Unit)**
This course examines central issues in child and adolescent psychotherapy and the mainstream treatment approaches including psychoanalytic, play, cognitive-behavioral and behavioral therapy. Emphasis on high-frequency problems for which children/adolescent enter therapy. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 413-6 or COUN 414-6 Human Development

**COUN 451-0 Topics in Counseling (0.5 Unit)**
This course will explore various theoretical and applied areas of counseling, life-course development, and intervention. Topics include biological bases of behavior, human neuropsychology, psychopharmacology, advanced psychopathology, career development and assessment, and rehabilitation counseling.

**COUN 452-0 Theory & Technique of Substance Abuse Counseling (1 Unit)**
The course focuses on the development of skills, concepts, and core competencies related to the theory and practice of addiction counseling.

**COUN 452-6 Theory & Technique of Substance Abuse Counseling (1 Unit)**
The course focuses on the development of skills, concepts, and core competencies related to the theory and practice of addiction counseling. This course includes screening, assessment of dependence, change, and recovery, co-occurring disorders, prevention, intervention, and treatment.

**COUN 453-0 Evaluation & Treatment of Trauma Disorders (1 Unit)**
The course offers a review of the nature of trauma and posttraumatic conditions; the psychobiology underlying stress, trauma, and dissociation, and the treatment of posttraumatic conditions.

**COUN 453-6 Evaluation & Treatment of Trauma Disorders (1 Unit)**
The course offers a review of the nature of trauma and posttraumatic conditions; the psychobiology underlying stress, trauma, and dissociation, and the treatment of posttraumatic conditions. Requirement: Counseling@Northwestern Students Only.

**COUN 455-0 Psychopharmacology for Clinical Mental Health Counselors (1 Unit)**
The course explores the role of psychopharmacological medication in mental health treatment. Students learn approved indications and contraindications of psychopharmacological medications for mental health and substance use conditions in adults and children, and practice how to consult with clients and medical professionals about medication-related issues. Requirement.

**COUN 455-6 Psychopharmacology for Clinical Mental Health Counselors (1 Unit)**
The course explores the role of psychopharmacological medication in mental health treatment. Students learn approved indications and contraindications of psychopharmacological medications for mental health and substance use conditions in adults and children, and practice how to consult with clients and medical professionals about medication-related issues. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 415-6 Psychopathology in Counseling

**COUN 477-6 Introduction to Clinical Practice (1 Unit)**
This course is designed exclusively for students entering the program with nontraditional backgrounds and making a career transition into the field of counseling. A primary objective of the course is to help students acquire an orientation to the counseling profession, explore a range of basic issues relevant to the field, and learn about the role of a mental health counselor. Requirement: Counseling@Northwestern Students Only.

**COUN 478-6 Introduction to Clinical Interviewing (1 Unit)**
This course is designed exclusively for students entering the program with nontraditional backgrounds and making a career transition into the field of counseling. A primary objective of the course is to help students acquire an orientation to the counseling profession, explore a range of basic issues relevant to the field, and learn about the role of a mental health counselor. Requirement: Counseling@Northwestern Students Only.

**COUN 479-1 Introduction to Clinical Practice (1 Unit)**
This multi-quarter course will enhance the development of clinical skills in career changers through understanding both the pragmatics and the complexities of the clinical interviewing process and the treatment process as a whole.

**COUN 479-2 Introduction to Clinical Practice (1 Unit)**
This multi-quarter course will enhance the development of clinical skills in career changers through understanding both the pragmatics and
the complexities of the clinical interviewing process and the treatment process as a whole.

COUN 479-3 Introduction to Clinical Practice (1 Unit)
This multi-quarter course will enhance the development of clinical skills in career changers through understanding both the pragmatics and the complexities of the clinical interviewing process and the treatment process as a whole.

COUN 479-6 Current Topics in Counseling (1 Unit)
This course will center around many topics in contemporary counseling of relevant to the beginning practitioner. The objective is to introduce a range of selected clinical topics, issues, dilemmas, treatment orientations, and modalities that will be encountered as students move into their fieldwork experience. Requirement: Counseling@Northwestern Students Only.

COUN 480-1 Counseling Methods I: Skills for Counseling & Psychotherapy (1 Unit)
This course is the first in a three-course sequence focused on the development of skills, concepts, and core competencies related to the practice of counseling and psychotherapy. This course includes evaluation of practice sessions with actual clients and must be taken in conjunction with Supervised Practicum in Counseling.

COUN 480-2 Counseling Methods II: Assessment and Intervention (1 Unit)
The course is the second in a three-course sequence focused on the development of skills, concepts, and core competencies related to the practice of counseling and psychotherapy. This course includes evaluation of practice sessions with actual clients and must be taken in conjunction with Supervised Practicum in Counseling.

COUN 480-3 Counseling Methods III: Outreach, Prevention, and Advocacy (1 Unit)
This course will introduce students to the process of providing counseling from a multi-cultural perspective in diverse society. Students will gain an understanding of how social and cultural identity issues and tensions surface in counseling, how power and privilege may affect therapy alliance and outcomes, the nature of microaggressions. Focus will be on understanding self and clients in cultural context. The counseling profession’s value of social justice advocacy for clients will also be examined.

COUN 480-6 Counseling Methods I: Skills for Counseling & Psychotherapy (1 Unit)
This course is the first in a three-course sequence focused on the development of skills, concepts, and core competencies related to the practice of counseling and psychotherapy. This course includes evaluation of practice sessions with actual clients and must be taken in conjunction with Supervised Practicum in Counseling. Requirement: Counseling@Northwestern Students Only.

COUN 481-0 Supervised Practicum in Counseling (0 Unit)
Three quarters of supervised field training, clinical supervision and case consultation of approximately 16-20 hours per week, with optional fourth quarter; in conjunction with Methods 1-3. Arranged with program training director. For master’s students in Counseling Psychology.

COUN 481-1 Supervised Practicum in Counseling (1 Unit)
Three quarters of supervised field training, clinical supervision and case consultation of approximately 16-20 hours per week, with optional fourth quarter; in conjunction with Methods 1-3. Arranged with program training director. For master’s students in Counseling.

COUN 481-2 Supervised Practicum in Counseling (1 Unit)
Three quarters of supervised field training, clinical supervision and case consultation of approximately 16-20 hours per week, with optional fourth quarter; in conjunction with Methods 1-3. Arranged with program training director. For master’s students in Counseling Psychology.

COUN 482-1 Supervised Internship in Counseling (1 Unit)
Three quarters supervised field experience of approximately 24 hours per week with optional fourth quarter. Arranged with Clinical training director. For master’s students in Counseling Psychology. Prerequisites: Practicum in Counseling

COUN 482-2 Supervised Internship in Counseling (1 Unit)
Three quarters supervised field experience of approximately 24 hours per week with optional fourth quarter. Arranged with Clinical training director. For master’s students in Counseling Psychology. Prerequisites: Practicum in Counseling

COUN 482-3 Supervised Internship in Counseling (1 Unit)
Three quarters supervised field experience of approximately 24 hours per week with optional fourth quarter. Arranged with Clinical training director. For master’s students in Counseling Psychology. Prerequisites: Practicum in Counseling

COUN 482-4 Supervised Internship in Counseling (1 Unit)
Three quarters supervised field experience of approximately 24 hours per week with optional fourth quarter. Arranged with Clinical training director. For master’s students in Counseling Psychology. Prerequisites: Practicum in Counseling

COUN 482-6 Counseling Methods III: Outreach, Prevention, and Advocacy (1 Unit)
This course is the third in a three-course sequence focused on the development of skills, concepts, and core competencies related to the practice of counseling and psychotherapy. This course includes evaluation of practice sessions with actual clients and must be taken in conjunction with supervised practicum in Counseling. Special emphasis on working outside the therapy room. Requirement: Counseling@Northwestern Students Only. Prerequisites: COUN 481-6 and COUN 487-6 Methods II and Practicum II

COUN 483-1 Ethical and Legal Issues in Counseling (1 Unit)
The course gives students in depth understanding and decision-making skills regarding major ethical and legal issues in the practice of professional counseling. Exploration of the American Counseling Association (ACA) ethical standards and their application to treatment; review of ethical decision-making models; and major ethical and legal issues in practice.

**COUN 483-2 Cultural Diversity in Counseling (1 Unit)**

This course will introduce students to the process of providing counseling from a multi-cultural perspective in diverse society. Students will gain an understanding of how social and cultural identity issues and tensions surface in counseling, how power and privilege may affect therapy alliance and outcomes, the nature of microaggressions. Focus will be on understanding self and clients in cultural context. The counseling profession's value of social justice advocacy for clients will also be examined.

**COUN 483-3 Advanced Topics in Clinical Mental Health Counseling (1 Unit)**

Discussion of clinical issues in seminar format; in conjunction with COUN 482-3. Prerequisites: COUN 481-1, COUN 481-2, COUN 481-3.

**COUN 483-6 Ethics and Legal Issues in Counseling (1 Unit)**

The course gives students indepth understanding and decision-making skills regarding major ethical and legal issues in the practice of professional counseling. Exploration of the American Counseling Association (ACA) ethical standards and their application to treatment; review of ethical decision-making models; and major ethical and legal issues in practice. Requirement: Counseling@Northwestern Students Only.

**COUN 484-1 Individual Diagnosis and Assessment (1 Unit)**

This course explores standardized psychometric tests of personality, intelligence, and vocational interest; individual measures of intelligence and personality, including projectives.

**COUN 484-2 Individual Diagnosis and Assessment (1 Unit)**

This course explores standardized psychometric tests of personality, intelligence, and vocational interest; individual measures of intelligence and personality, including projectives.

**COUN 484-3 Individual Diagnosis and Assessment (1 Unit)**

This course explores standardized psychometric tests of personality, intelligence, and vocational interest; individual measures of intelligence and personality, including projectives.

**COUN 484-6 Cultural Diversity in Counseling (1 Unit)**

This course will introduce students to the process of providing counseling from a multi-cultural perspective in diverse society. Students will gain an understanding of how social and cultural identity issues and tensions surface in counseling, how power and privilege may affect therapy alliance and outcomes, the nature of microaggressions. Focus will be on understanding self and clients in cultural context. The counseling profession's value of social justice advocacy for clients will also be examined. Requirement: Counseling@Northwestern Students Only.

**COUN 485-6 Advanced Topics in Clinical Mental Health Counseling (1 Unit)**

Review of all aspects of roles of professional counselors including history, roles, organizational structures, counselor identity, and licensure requirements. Review of current treatment topics. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 406-6 Research Methods

**COUN 486-6 Supervised Practicum in Counseling I (1 Unit)**

The practicum experience offers fieldwork experience in which students offer clinical mental health counseling services to adult clients in a practicum setting with mild mental health presenting issues. It is designed to accommodate the student's initial level of professional development and to promote counselor identity, multicultural awareness, and the development of clinical skills. Requirement: Counseling@Northwestern Students Only.

**COUN 487-6 Supervised Practicum in Counseling II (1 Unit)**

The practicum experience offers fieldwork experience in which students offer clinical mental health counseling services to adult clients in a practicum setting with mild mental health presenting issues. It is designed to accommodate the student's initial level of professional development and to promote counselor identity, multicultural awareness, and the development of clinical skills. Requirement: Counseling@Northwestern Students Only. Prerequisites: COUN 480-6 and COUN 486-6 Methods I and Practicum I

**COUN 488-6 Supervised Practicum in Counseling III (1 Unit)**

Practicum offers fieldwork experience in which students offer clinical mental health counseling services to adult clients in a practicum setting with mild mental health presenting issues. It is designed to accommodate the student's initial level of professional development and to promote counselor identity, multicultural awareness, and the development of clinical skills. Requirement: Counseling@Northwestern Students Only. Prerequisites: COUN 481-6 and COUN 487-6 Methods II and Practicum II

**COUN 489-6 Supervised Internship in Counseling I (1 Unit)**

Internship offers advanced fieldwork experience in which students engage in a comprehensive clinical training experience where they enact all aspects of the role of a clinical mental health counselor. Internship in Counseling I, II, & III, equip students with basic client management tasks and skills. Additionally, students participate in role-related clinical service and training activities as permitted and/or required by the agency. The Internship is designed to accommodate the student's moderate level of professional development and to promote counselor identity, multicultural awareness, and the development of clinical skills. Requirement: Counseling@Northwestern Students Only. Prerequisites: COUN 482-6 and COUN 488-6 Methods III and Practicum III

**COUN 490-6 Supervised Internship in Counseling II (1 Unit)**

Internship offers advanced fieldwork experience in which students engage in a comprehensive clinical training experience where they enact all aspects of the role of a clinical mental health counselor. Internship in Counseling I, II, & III, equip students with basic client management tasks and skills. Additionally, students participate in role-related clinical service and training activities as permitted and/or required by the agency. The Internship is designed to accommodate the student's moderate level of professional development and to promote counselor identity, multicultural awareness, and the development of clinical skills. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 489-6 Internship I

**COUN 491-0 Readings in Counseling (1 Unit)**

Permission of instructor and department required. Request for Independent Study/Readings Course form available before registration at the Office of Student Affairs.

**COUN 491-6 Supervised Internship in Counseling III (1 Unit)**

The internship experience offers advanced fieldwork experience in which students engage in a comprehensive clinical training experience where they enact all aspects of the role of a clinical mental health counselor. Internship in Counseling I, II, & III, equip students with basic client management tasks and skills. Additionally, students participate in role-related clinical service and training activities as permitted and/or required by the agency. Requirement: Counseling@Northwestern Students Only. Prerequisite: COUN 490-6 Internship II
COUN 499-0 Independent Study in Counseling (1 Unit)
Permission of instructor and department required for students to request Independent Study/Readings. Course form seeking permission must be completed before registration at the Office of Student Affairs.

COUN 582-1 Advanced Internship in Counseling (0 Unit)
Three quarters of supervised field experience of approximately 24 hours per week with optional fourth quarter. (Only for those students who have no other registration except the externship and need full-time status for deferment of loans.)

COUN 582-2 Supervised Internship in Counseling (0 Unit)
Three quarters of supervised field experience of approximately 24 hours per week with optional fourth quarter. (Only for those students who have no other registration except the externship and need full-time status for deferment of loans.)

COUN 582-3 Supervised Internship in Counseling (0 Unit)
Three quarters of supervised field experience of approximately 24 hours per week with optional fourth quarter. (Only for those students who have no other registration except the externship and need full-time status for deferment of loans.)

COUN 584-0 Advanced Internship in Counseling (0 Unit)
This is an advanced-level pre-internship supervised field experience in an approved clinical setting. Arranged with program training director.

Dance (DANCE)

DANCE 315-0 Dance Criticism (1 Unit)
Critical and theoretical thought of writers on Western theatrical dance.

DANCE 326-0 Advanced Improvisation (1 Unit)
Improvisation as a source for composition and performance. For musicians and actors wishing to expand dance vocabulary and for dancers exploring the musical and theatrical dimensions of their art. Focus on interrelationships between people moving and between the performing arts that students bring to the course.
Prerequisite: DANCE 101-3 or consent of instructor.

DANCE 345-0 Studies in Collaboration (1 Unit)
Workshop exploration of collaboration as well as historical and theoretical perspectives. Seminar, practicum. Through studio work, reading, and discussion, dancers and musicians will explore our shared language.

DANCE 355-0 Dance in Education (1 Unit)
Organizing and teaching dance technique and creative movement for children and adolescents. Creative play, movement exploration, acquisition of basic motor skills, links to the classroom. Lecture, laboratory, and field experiences.

DANCE 356-0 Expressive Arts Therapy (1 Unit)
Overview of dance, drama, and art therapies for treating disabled, mentally ill, or other special populations. Introduces diverse theoretical perspectives in the role and use of art forms as therapeutic modalities. Symbolic meaning, group dynamics, and the language of movement as it relates to personality, body image, and expression.

DANCE 499-0 Independent Study (1 Unit)
May be repeated for credit.
Prerequisites: Permission of instructor.

Data Science (DATA_SCI)

DATA_SCI 401-1 Data-Driven Research in Physics, Geophysics, and Astronomy (0 Unit)

Earth and Planetary Sciences (EARTH)

EARTH 300-0 Earth and Planetary Materials (1 Unit)
Mineralogy of the earth and planets from atomic to continental scales, focusing on structure, composition, identification, and physical properties of minerals as they pertain to geological and societal applications. Recommended Background: At least one course in each of chemistry, physics, and math.
Natural Sciences Distro Area

EARTH 301-0 Petrology: Evolution of Crustal and Mantle Rocks (1 Unit)
Origin, composition, and classification of igneous, metamorphic, and sedimentary rocks. Application of laboratory characterization and basic thermodynamics to interpreting observed rock textures and mineral assemblages in terms of geological processes.
Prerequisite: EARTH 300-0 or consent of instructor.

**Natural Sciences Distro Area**

**EARTH 302-0 Geological Thermodynamics (1 Unit)**
Finite strain theory, solid solution thermodynamics, phase transitions, subduction zone processes, seismic velocity structures, mineral equations of state.
Prerequisite: EARTH 301-0 or consent of instructor.

**Natural Sciences Distro Area**

**EARTH 310-0 Aqueous Geochemistry (1 Unit)**
The geochemistry of rivers, groundwater, lakes, and seawater. Topics include thermodynamics, kinetics, acids and bases, pH and alkalinity, carbonate equilibria, chemical weathering, and numerical modeling.
Recommended Background: At least one year of chemistry coursework.

**Natural Sciences Distro Area**

**EARTH 312-0 Stable Isotope Geochemistry (1 Unit)**
Fractionation and distribution of stable isotopes (C, H, N, O, S) in the biosphere, hydrosphere, atmosphere, and geosphere. Isotopic biogeochemistry, environmental problems, and global climate change.
Recommended Background: EARTH 201-0 and EARTH 203-0, or equivalent.

**Natural Sciences Distro Area**

**EARTH 313-0 Radiogenic Isotope Geochemistry (1 Unit)**
Application of radiogenic isotopes to problems in geochemistry, petrology, hydrology, oceanography, ecology, and environmental science. Includes radioactive decay, nucleosynthesis, cosmochemistry, geochronology, mixing processes, and numerical modeling.
Recommended Background: At least one year of chemistry coursework.

**Natural Sciences Distro Area**

**EARTH 314-0 Organic Geochemistry (1 Unit)**
The sources and fates of organic matter in the natural environment; global cycling of organic carbon; applications to the study of modern and ancient environments. Recommended Background: at least one quarter of earth or environmental science, and one quarter of chemistry. Taught with CIV_ENV 314-0; may not receive credit for both courses.

**Natural Sciences Distro Area**

**EARTH 323-0 Seismology and Earth Structure (1 Unit)**
Elastic theory, seismic waves, seismometers and seismograms, ray paths, travel times; internal structure of the earth; field seismology.
Recommended Background: EARTH 202-0, calculus, ordinary differential equations, and some exposure to complex numbers. No prior earth science experience required.

**Natural Sciences Distro Area**

**EARTH 324-0 Earthquakes and Tectonics (1 Unit)**
Earthquakes: location, characteristics, origin, mechanism, and relation to plate motions; seismic hazard. Recommended Background: Calculus, ordinary differential equations, and some exposure to complex numbers. No prior earth science experience required.

**Natural Sciences Distro Area**

**EARTH 327-0 Geophysical Time Series Analysis (1 Unit)**
Analysis of seismic and other geophysical data. Sampling, windowing, discrete and fast Fourier transforms, z-transforms, deconvolution, and filtering. Recommended Background: EARTH 202-0 and calculus differential equations; or consent of instructor.

**Natural Sciences Distro Area**

**EARTH 330-0 Sedimentary Geology (1 Unit)**
Sedimentary rocks; stratigraphy; local, regional, and global correlation. Ancient depositional systems; facies analysis in context of tectonic, eustatic, and climatic controls on deposition. Recommended Background: EARTH 201-0 or consent of instructor.

**EARTH 331-0 Field Problems in Sedimentary Geology (1 Unit)**
Field methods in stratigraphy and sedimentology; interpretation of depositional systems, facies models, and sequence stratigraphy based on field observations. Includes 3½-week late-summer field trip to Colorado and Utah.
Prerequisite: EARTH 330-0.

**EARTH 335-0 Tectonics and Structural Geology (1 Unit)**
Deformation of rock masses: strain, fracture, slip, stress, and rheologic regimes; rock structures; folds, faults, foliations; seismic parameters in tectonic studies; orogenic belts and their tectonic evolution.
Recommended Background: EARTH 201-0, and at least one credit of physics; or consent of instructor.

**EARTH 340-0 Physics of Weather & Climate (1 Unit)**
An investigation of atmospheric processes and the physical laws that govern them. Topics covered include atmospheric composition and structure, radiative transfer, thermodynamics, convection, precipitation, and the general circulation of the three-dimensional atmosphere. When possible, course content will engage with contemporaneous atmospheric conditions, and provide students with a better understanding of their meteorological and climatic environments. Recommended Background: Completion of full year of calculus Math and Physics.

**Natural Sciences Distro Area**

**EARTH 341-0 Quaternary Climate Change: Ice Ages to the Age of Oil (1 Unit)**
Methods for reconstructing and dating past environmental changes, causes of natural climate change, and major climate events of the Quaternary through the present. Their relevance for understanding current climate change.
Prerequisite: At least one 200-level EARTH course; or consent of instructor.

**Natural Sciences Distro Area**

**EARTH 342-0 Contemporary Energy and Climate Change (1 Unit)**
Interdisciplinary course examining global energy use and associated challenges, including the history of energy use, the science of climate change, and technological, economic, and environmental aspects of various energy sources. Registration reserved for seniors majoring in math, science, or engineering, and graduate students in all disciplines. Taught with ISEN 410-0; may not receive credit for both courses.

**Natural Sciences Distro Area**

**EARTH 343-0 Earth System Modeling (1 Unit)**
Introduction to the art and science of reducing Earth’s complex systems into simple numerical models to build a better understanding of how components interact and evolve. Recommended Background: At least one 200-level course in Earth or Environmental Science, one course in each of calculus and physics.

**Natural Sciences Distro Area**

**EARTH 350-0 Physics of the Earth (1 Unit)**
Solid-earth geophysics: the earth’s gravity field, the earth’s magnetic field, interior of the earth, heat flow, elementary wave propagation, plate tectonics.
Prerequisites: second-year standing in ISP; or comparable background in mathematics and physics and consent of both instructor and ISP director.

**EARTH 352-0 Global Tectonics (1 Unit)**
Recommended Background: EARTH 202-0, and completion of first-year calculus and physics.

EARTH 353-0 Mathematical Inverse Methods in Earth and Environmental Sciences (1 Unit)
Theory and application of inverse methods to gravity, magnetotelluric, seismic, and other data. Nonlinear, linearized, underdetermined, and mixed-determined problems and solution methods, including regularized least-squares and neighborhood algorithms. Recommended Background: Linear algebra and differential calculus of multivariable functions.

EARTH 360-0 Instrumentation and Field Methods (1 Unit)
Theory and practice on electronic instrumentation for monitoring and measurement in earth sciences, including data loggers, conceptual design and construction of electronic sensors, signal processing, data management, and network design. Recommended Background: 3 EARTH courses.

EARTH 361-0 Scientific Programming in Python (1 Unit)
Introduction to coding, scientific computing, and visualization for analyzing data in the physical sciences. Emphasis on Python, but Unix, shell scripting, and Generic Mapping Tools are also introduced. Students undertake a significant final coding project individually or in pairs.

Formal Studies Distro Area

EARTH 362-0 Data Analysis for Earth and Planetary Sciences (1 Unit)
Types and characteristics of earth science data, development and applications of model types, observational and systematic sources of uncertainties and their characterization, spatial and temporal predictions. Recommended Background: EARTH 201-0 and EARTH 202-0, or equivalent.

Formal Studies Distro Area

EARTH 370-0 Geobiology (1 Unit)
A technical overview of the major topics of geo(micro)biology highlighting the fossil record, biogeochemical cycling, biominalization, key tools of the field, historical geobiology, and astrobiology. Recommended Background: EARTH 201-0 (concurrent enrollment acceptable) and first-year chemistry.

Natural Sciences Distro Area

EARTH 371-0 Biogeochemistry (1 Unit)
The cycling of biogenic elements (C, N, S, Fe, Mn) in surficial environments. Emphasis on microbial processes and isotopic signatures. Recommended Background: At least one course in biology, chemistry, and earth or environmental science. Taught with CIV_ENV 317-0; may not receive credit for both courses.

Natural Sciences Distro Area

EARTH 373-0 Microbial Ecology (1 Unit)
This course will provide a framework for understanding the role of microbes in natural environments in terms of cell numbers, metabolisms, and interactions with geochemical cycles. We will delve deeply into the interactions between microbial populations, higher organisms, and even our own bodies. The course will finish on a survey of microbial composition and dynamics in key settings across the planet. Recommended Background: Basic understanding of chemistry, biology, and earth science.

Natural Sciences Distro Area

EARTH 380-0 Forming a Habitable Planet (1 Unit)
Formation and evolution of planets permitting life; global geophysical and geochemical processes critical in our planet’s development; prospects for life within our solar system and beyond; exoplanet discovery and characteristics. Recommended Background: At least one course in chemistry, and physics.

Natural Sciences Distro Area

EARTH 381-0 Planet Formation and Evolution (1 Unit)
Survey of planet formation processes including growth from the first solids to the giant planets as well as the internal evolution of planetary bodies. Recommended Background: EARTH 201-0, first-year physics, and calculus.

Natural Sciences Distro Area

EARTH 382-0 Cosmochemistry (1 Unit)
Examine the chemical composition of the universe, the Sun, the planets, and their building blocks. Learn the origin of the elements and their evolution through Solar System history. Use isotopic data to trace cosmic genetic relationships and date important events like the birth of the first solids in the Solar System. Understand the chemical processes that segregate elements into different astrophysical and planetary reservoirs. Observe primitive and evolved meteoritic and planetary materials in the laboratory. Recommended Background: Completion of a full year of chemistry and calculus, and the earth science 200-level courses.

Natural Sciences Distro Area

EARTH 383-0 Planetary Physics (1 Unit)
Quantitative survey of planetary science including dynamics, atmospheres, surfaces, interiors, magnetospheres, rings, and small bodies. Recommended Background: EARTH 201-0, first-year physics, and calculus.

Natural Sciences Distro Area

EARTH 390-0 Special Topics in Earth and Planetary Science (1 Unit)
Topics of current interest to students and faculty. Prerequisites vary. May be repeated for credit with different topic.

EARTH 438-0 Advanced Topics in Geophysics (1 Unit)
Topics include tectonophysics and the bodily structure of the Earth, dislocation theory in Earth motions, glaciology, geochronology, and emerging and new areas of geophysics. Intended for advanced undergraduate students and graduate students.

EARTH 440-0 Advanced Topics in Geochemistry (1 Unit)
Topics at the frontiers of geochemistry research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

EARTH 450-0 Advanced Topics (1 Unit)
Topics at the frontiers of research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

EARTH 451-0 Advanced Topics in Paleoclimate (1 Unit)
Methodology in paleoclimate: stable-isotope, paleoecological, and other methods for reconstructing the past climate. Fundamental principles of climate change on the time scale of thousands to millions of years. Climate reconstructions from the Cretaceous to the present. Intended for advanced undergraduate students and graduate students.

EARTH 462-0 Advanced Topics in Seismology (1 Unit)
Topics at the frontiers of seismology research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

EARTH 499-0 Independent Study (1-4 Units)
Study of special problems under the direct supervision of one or more members of the teaching staff. A comprehensive report and/or a comprehensive examination is required. May be repeated for credit.

EARTH 519-0 Responsible Conduct of Research Training (0 Unit)
All Earth and Planetary Sciences Graduate Students and Post Doctoral Fellows must complete the Responsible Conduct of Research (RCR) Training in their first year of the program.

EARTH 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Economics (ECON)

ECON 307-0 Economics of Medical Care (1 Unit)
Application of microeconomics to the study of health insurance and the health care sector. Topics include: design and financing of health insurance, public and private demand for medical care, role of competition, regulation of hospitals and physicians, roles of nonprofit and for-profit organizations, and technological change.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 308-0 Money and Banking (1 Unit)
The role of money, banking, and financial markets in the modern economy. Topics include: function and history of money, financial flows, evolving nature of banks and their regulation, monetary policy, modern central bank practices, effect of monetary policy on economic outcomes, and the response to financial crises.
Prerequisites: ECON 281-0, ECON 310-1, ECON 311-0.

ECON 309-0 Public Finance (1 Unit)
Understanding the role of government in the economy in theory and practice. Topics include: structure and implications of various tax instruments, role of public debt, and methods for evaluating government expenditures and programs.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 310-1 Microeconomics (1 Unit)
A more mathematically formal and rigorous treatment of the core concepts of microeconomics introduced in ECON 202-0. Topics include: consumer behavior and the theory of demand, costs of production and the nature of equilibrium in competitive and monopolistic markets.
Prerequisites: ECON 201-0, ECON 202-0, MATH 220-1.
Social Behavioral Sciences Distro Area

ECON 310-2 Microeconomics (1 Unit)
The continuation of the intermediate microeconomics sequence provides tools to analyze social wellbeing, social choice, risk and uncertainty, information asymmetries, competitive independencies between firms (game theory), market spillovers and general equilibrium.
Prerequisite: ECON 310-1.

ECON 311-0 Macroeconomics (1 Unit)
A more mathematically formal and rigorous treatment of the core concepts of macroeconomics introduced in ECON 201-0. Topics include: aggregate consumption, inflation, unemployment, growth, international balances between countries, and the role of monetary and fiscal policy.
Prerequisites: ECON 201-0, ECON 202-0, MATH 220-1.
Social Behavioral Sciences Distro Area

ECON 315-0 Topics in Economic History (1 Unit)
Topics vary and may cover the economic history of a particular country or region, or a specific issue in economic history. May be taken twice for credit with different topics.
Prerequisites: ECON 281-0, ECON 310-1, ECON 311-0.

ECON 316-0 Advanced Topics in Macroeconomics (1 Unit)
This course is for students looking for advanced and rigorous analysis in macroeconomics. Topics vary and may include: growth, business cycles, unemployment and search, monetary economics, macroeconomic policy, inter-temporal choice, and general equilibrium.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 311-0, MATH 220-2, MATH 230-1.

ECON 318-0 History of Economic Thought (1 Unit)
Development of economic thought from the advent of the mercantilists to the formation of current schools of economics.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 311-0.

ECON 323-1 Economic History of the United States Before 1865 (1 Unit)
Economic development of the United States with emphasis on changing structure and performance of the economy: Colonial period to 1865.
Prerequisites: ECON 281-0, ECON 310-1, ECON 311-0.

ECON 323-2 Economic History of the United States 1865 to Present (1 Unit)
Economic development of the United States with emphasis on changing structure and performance of the economy: 1865 to the present.
ECON 323-1 is not a prerequisite.
Prerequisites: ECON 281-0, ECON 310-1, ECON 311-0.

ECON 324-0 Western Economic History (1 Unit)
Western European developments from 1750 to the present. Topics include: demographic, technical, social, and economic change.
Prerequisites: ECON 281-0, ECON 310-1, ECON 311-0.

ECON 325-0 Economic Growth & Development (1 Unit)
Macroeconomic aspects of long-term patterns of economic development, and the examination of differences in the income levels and growth performances across countries. The role of investment, education, population, and technological change in economic growth.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 311-0.

ECON 326-0 The Economics of Developing Countries (1 Unit)
Microeconomic issues in underdeveloped countries. Topics include: land use, labor, migration, credit and microfinance, informal and formal insurance, famine, education and health.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 327-0 Economic Development in Africa (1 Unit)
Economic change in sub-Saharan Africa, emphasizing current issues and policies in their historical contexts. Agriculture and rural development, industrialization, and international economic relations.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 326-0.

ECON 329-0 Experimental Economics (1 Unit)
Application of experimental methods to study economic questions. Students will learn about, participate in, and potentially design, experiments to gain insight into economic theories about decision-making, games, and markets.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 330-0 Behavioral Economics (1 Unit)
Understanding of how humans make choices in economic situations. The incorporation of psychology and/or sociology into economics to gain deeper insight into economic behavior, to make better predictions, and to generate improved policy prescriptions.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 331-0 Economics of Risk and Uncertainty (1 Unit)
Models of decision making under uncertainty. Use of these models to understand economic phenomena such as investments in financial assets, insurance, contracting, and auctions.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, MATH 300-0 or equivalent.

ECON 335-0 Political Economics (1 Unit)
The analysis of political motivations and policy outcomes using economic models of social choice theory and voting theory. Application of formal theory to contemporary and historical public policy decisions.
Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 336-0 Analytic Methods for Public Policy Analysis (1 Unit)
Study of methodological problems in public policy analysis and an examination of how economists perform policy analysis in practice. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 337-0 Economics of State and Local Governments (1 Unit)
Economic functions and financing of state and local governments in theory and practice, costs and demands for local public services, and the role of government finance in urban and regional growth. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 339-0 Labor Economics (1 Unit)
The theory and empirical analysis of employment relationships. Topics include: decision to participate in the labor market, tradeoff between labor and leisure, demand for labor by firms, matching of workers and jobs, role and effect of trade unions, minimum wage legislation, labor mobility, and human capital acquisition. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 311-0.

ECON 340-0 Economics of the Family (1 Unit)
Application of microeconomic theory to the analysis of family issues. Topics include: marriage, cohabitation, decision to have children, divorce, credit and insurance, legacies, bargaining within the household, and division of household labor. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 341-0 Economics of Education (1 Unit)
The economic analysis of education. Topics include: returns to schooling, individual decisions to invest in education, the production of education, markets for schools and teachers, financing, and public policy. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 342-0 Economics of Gender (1 Unit)
Analysis of gender differences in employment, earnings and division of labor in the household. Topics include: the status of women around the world, education, marriage, fertility, labor supply, household decision-making, and discrimination. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 349-0 Industrial Economics (1 Unit)
Examination of the competitive and cooperative strategies employed by profit-maximizing firms in a wide range of market structures. Topics include: the setting of prices and outputs, product quality and variety, competitive responses, entry barriers, mergers and acquisitions, and relationships with suppliers and distributors. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 350-0 Monopoly Competition & Public Policy (1 Unit)
Application of microeconomic tools to the problems and issues caused by monopoly power in the context of antitrust law, public utility regulation, and intellectual property. Use of economic theory and landmark legal cases to study the purpose and development of policies to mitigate anti-competitive practices, and highlight currently unresolved public policy debates. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 351-0 Law and Economics (1 Unit)
Use of economic analysis to understand the incentives, workings and efficiency of the legal system. Topics include: torts, contracts, property, criminal law, corporate law, and antitrust and regulation statutes. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 354-0 Issues in Urban and Regional Economics (1 Unit)
Factors affecting the spatial distribution of economic activity within cities and between different regions of a country. Choice of residential and workplace location. Applications of economic analysis to problems of urban areas such as housing markets, zoning restrictions, and racial and social patterns of employment and housing. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 355-0 Transportation Economics and Public Policy (1 Unit)
Economics of all forms of transportation and the regulatory and public policy environment in which they operate. Topics include: demand by passengers and freight shippers, costs of production, optimal pricing, regulatory interventions, subsidies, evaluation of investment, and dealing with congestion. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 359-0 Economics of Nonprofit Organizations (1 Unit)
The economic rationale for the non-profit sector in a mixed economy. Topics include: objectives and behavior of non-profit organizations, competition with commercial firms, volunteerism, and charitable donations. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 360-1 Foundations of Corporate Finance Theory (1 Unit)
How corporations allocate resources over time as facilitated by capital markets. Topics include: discounting techniques and applications, stock and bond valuation, asset pricing models, diversification and portfolio choice, capital budgeting, and basic option theory. (May not receive credit for both this course and BUS_INST 304-0. Not for students who have previously taken KELLG_FE 312-0.)

ECON 360-2 Investments (1 Unit)
Analysis of the issues and tradeoffs involved in forming a portfolio of financial instruments from the perspectives of individual and institutional investors. (Should not be taken by students who have taken KELLG_FE 312-0.)

ECON 361-0 International Trade (1 Unit)
Factors influencing trade in goods and services between countries and the implication of globalization. The reasons for, and the effects of, trade policy instruments such as tariffs, quotas, and voluntary export restrictions. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 311-0.

ECON 362-0 International Finance (1 Unit)
The determination of exchange rates, international asset prices and flows, currency crises, and the international transmission of macroeconomic disturbances. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2, ECON 311-0.

ECON 370-0 Environmental & Natural Resource Economics (1 Unit)
Externalities and the role of property rights, pollution, waste disposal, common property problems, renewable resource management, nonrenewable resource use and depletion, recyclable resources, water allocation, and management of public lands. (Students may not receive credit for both ECON 370-0 and ECON 372-0 or ECON 373-0.)

ECON 371-0 Economics of Energy (1 Unit)
Analysis of the functioning and regulation of electricity, oil and natural gas markets. Topics include: the role of competition and environmental concerns. Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 372-0 Environmental Economics (1 Unit)
Economic analysis of scarcity and incentives explaining environmental issues such as pollution and climate change. Modeling and evaluation of public policy. (Students may not receive credit for both ECON 370-0 and ECON 372-0.)

ECON 373-0 Natural Resource Economics (1 Unit)
Evaluation of economics models and public policy concerning natural resources such as farming, fisheries, forests, minerals, ores and fossil fuels. (Students may not receive credit for both ECON 370-0 and ECON 373-0). Prerequisites: ECON 281-0, ECON 310-1, ECON 310-2.

ECON 380-1 Game Theory (1 Unit)
Game theory is a collection of mathematical models of interaction among decision makers. It is used widely in understanding economic phenomena. This course will present some of the basic ideas of game theory. (Should not be taken by students who have completed MMSS 211-2). Prerequisites: ECON 310-1, ECON 310-2, MATH 220-2, MATH 230-1.

ECON 380-2 Game Theory (1 Unit)
This course extends the material presented in ECON 380-1 to explore more advanced models in game theory. Prerequisite: ECON 380-1 or consent of instructor.

ECON 381-1 Econometrics (1 Unit)
First part of the specialized sequence in econometrics. A more rigorous and higher level alternative to ECON 281-0. Economics majors completing ECON 381-1 will have the ECON 281-0 requirement waived. Prerequisites: ECON 310-1, (ECON 310-2, ECON 311-0 recommended), MATH 230-1, MATH 230-2, MATH 240-0 and MATH 314-0 (or equivalent).

ECON 381-2 Econometrics (1 Unit)
Second part of the upper-level econometrics sequence. The course introduces additional econometrics tools beyond those introduced in ECON 381-1. The course also explores the empirical application of these tools, and how to evaluate critically econometric and statistical methods used in policy analysis. Prerequisite: ECON 381-1, (ECON 310-2, ECON 311-0 recommended).

ECON 383-0 Applied Econometrics (1 Unit)
Methods for using actual data together with modern software to build, assess critically, and interpret econometric models of real world phenomena and policy issues. Prerequisites: ECON 281-0, ECON 310-1.

ECON 410-1 Microeconomics (1 Unit)
Theoretical treatment of the behavior of consumers and firms. Topics include: uncertainty, monotone comparative statics, competitive equilibrium, matching, game theory, informational asymmetries, and mechanism design (Required sequence.)

ECON 410-2 Microeconomics (1 Unit)
Theoretical treatment of the behavior of consumers and firms. Topics include: uncertainty, monotone comparative statics, competitive equilibrium, matching, game theory, informational asymmetries, and mechanism design (Required sequence.)

ECON 410-3 Microeconomics (1 Unit)
Theoretical treatment of the behavior of consumers and firms. Topics include: uncertainty, monotone comparative statics, competitive equilibrium, matching, game theory, informational asymmetries, and mechanism design (Required sequence.)

ECON 411-1 Macroeconomics (1 Unit)
Theoretical methodologies and their application to the study of dynamic economies. Topics include: economic growth and business cycles, the determinants of consumption and investment, and the effects of monetary and fiscal policy. (Required sequence.)

ECON 411-2 Macroeconomics (1 Unit)
Theoretical methodologies and their application to the study of dynamic economies. Topics include: economic growth and business cycles, the determinants of consumption and investment, and the effects of monetary and fiscal policy. (Required sequence.)

ECON 411-3 Macroeconomics (1 Unit)
Theoretical methodologies and their application to the study of dynamic economies. Topics include: economic growth and business cycles, the determinants of consumption and investment, and the effects of monetary and fiscal policy. (Required sequence.)

ECON 412-1 Economic Theory and Methods (1 Unit)
Methodological aspects of modern economic theory. Problems in economic decision making, strategic interaction, and welfare economics.

ECON 412-2 Economic Theory and Methods (1 Unit)
Methodological aspects of modern economic theory. Problems in economic decision making, strategic interaction, and welfare economics.

ECON 412-3 Economic Theory and Methods (1 Unit)
Methodological aspects of modern economic theory. Problems in economic decision making, strategic interaction, and welfare economics.

ECON 414-1 Economics of Information (1 Unit)
Information imperfections and asymmetries in markets and organizations. The theory and application of mechanism design to markets and contracts. Topics include: modeling information, search, the value of information, games with incomplete information, adverse selection and moral hazard.

ECON 414-2 Economics of Information (1 Unit)
Information imperfections and asymmetries in markets and organizations. The theory and application of mechanism design to markets and contracts. Topics include: modeling information, search, the value of information, games with incomplete information, adverse selection and moral hazard.

ECON 414-3 Economics of Information (1 Unit)
Information imperfections and asymmetries in markets and organizations. The theory and application of mechanism design to markets and contracts. Topics include: modeling information, search, the value of information, games with incomplete information, adverse selection and moral hazard.

ECON 415-1 Advanced Microeconomics (1 Unit)
Current topics in microeconomic theory. Mathematical formulations and techniques and their applications in fields such as political economy, industrial organization, and finance.

ECON 415-2 Advanced Microeconomics (1 Unit)
Current topics in microeconomic theory. Mathematical formulations and techniques and their applications in fields such as political economy, industrial organization, and finance.

ECON 416-1 Advanced Macroeconomics (1 Unit)
Recent contributions to macroeconomics. Topics may include: models with heterogeneous agents, the role of financial markets and of the housing market, models of search and unemployment, the role of market power in good markets, and inequality.

ECON 416-2 Advanced Macroeconomics (1 Unit)
Recent contributions to macroeconomics. Topics may include: models with heterogeneous agents, the role of financial markets and of the housing market, models of search and unemployment, the role of market power in good markets, and inequality.

ECON 416-3 Advanced Macroeconomics (1 Unit)
Recent contributions to macroeconomics. Topics may include: models with heterogeneous agents, the role of financial markets and of the housing market, models of search and unemployment, the role of market power in good markets, and inequality.
ECON 420-1 American Economic History (1 Unit)
Application of economic theory and other quantitative techniques to research on long-term factors in the development of the American economy.

ECON 420-2 European Economic History (1 Unit)
Application of economic theory and other quantitative techniques to studies of European economic evolution.

ECON 425-1 Development Economics (1 Unit)
Theoretical and empirical study of economic behavior and institutions in developing countries.

ECON 425-2 Development Economics (1 Unit)
Theoretical and empirical study of economic behavior and institutions in developing countries.

ECON 425-3 Development Economics (1 Unit)
Theoretical and empirical study of economic behavior and institutions in developing countries.

ECON 436-1 Public Finance (1 Unit)
Theoretical and empirical aspects of government spending and taxation.

ECON 436-2 Public Finance (1 Unit)
Theoretical and empirical aspects of government spending and taxation.

ECON 440-1 Labor Economics (1 Unit)
Theoretical and empirical study of the structure and functions of labor markets.

ECON 440-2 Labor Economics (1 Unit)
Theoretical and empirical study of the structure and functions of labor markets.

ECON 440-3 Labor Economics (1 Unit)
Theoretical and empirical study of the structure and functions of labor markets.

ECON 450-1 Industrial Organization (1 Unit)
Theoretical and empirical analysis of the behavior of firms, the structure of markets and related public policy issues.

ECON 450-2 Industrial Organization (1 Unit)
Theoretical and empirical analysis of the behavior of firms, the structure of markets and related public policy issues.

ECON 450-3 Industrial Organization (1 Unit)
Theoretical and empirical analysis of the behavior of firms, the structure of markets and related public policy issues.

ECON 460-1 International Economics (1 Unit)
Analytical tools for understanding international trade and international macroeconomics. Topics include: the relationship between trade and growth, international trade policy, international effects of monetary and fiscal policy, capital flows, and the choice of exchange rate regimes.

ECON 460-2 International Economics (1 Unit)
Analytical tools for understanding international trade and international macroeconomics. Topics include: the relationship between trade and growth, international trade policy, international effects of monetary and fiscal policy, capital flows, and the choice of exchange rate regimes.

ECON 460-3 International Economics (1 Unit)
Analytical tools for understanding international trade and international macroeconomics. Topics include: the relationship between trade and growth, international trade policy, international effects of monetary and fiscal policy, capital flows, and the choice of exchange rate regimes.

ECON 480-1 Econometrics (1 Unit)
Nonparametric and linear regression, identification, principles of statistical inference, extremum estimators, asymptotic statistical theory, time series analysis, discrete response analysis, structural microeconometrics. (Required sequence.)

ECON 480-2 Econometrics (1 Unit)
Nonparametric and linear regression, identification, principles of statistical inference, extremum estimators, asymptotic statistical theory, time series analysis, discrete response analysis, structural microeconometrics. (Required sequence.)

ECON 480-3 Econometrics (1 Unit)
Nonparametric and linear regression, identification, principles of statistical inference, extremum estimators, asymptotic statistical theory, time series analysis, discrete response analysis, structural microeconometrics. (Required sequence.)

ECON 481-1 Advanced Econometrics (1 Unit)
Advanced theory of identification, estimation, and statistical inference. Topics include partial identification of probability distributions, the bootstrap, refinements of asymptotic theory, and semi- and nonparametric structural microeconometrics.

ECON 481-2 Advanced Econometrics (1 Unit)
Advanced theory of identification, estimation, and statistical inference. Includes partial identification of probability distributions, the bootstrap, refinements of asymptotic theory, and semi- and nonparametric structural microeconometrics.

ECON 481-3 Advanced Econometrics (1 Unit)
Advanced theory of identification, estimation, and statistical inference. Topics include partial identification of probability distributions, the bootstrap, refinements of asymptotic theory, and semi- and nonparametric structural microeconometrics.

ECON 482-0 Applied Time-Series Econometrics (1 Unit)
Methods used to analyze time-series data with a focus on macroeconomic applications.

ECON 483-0 Applied Microeconometrics (1 Unit)
Methods used to analyze cross-section and panel data sets with an emphasis on applications.

ECON 489-1 Advanced Topics in Economics (1 Unit)
Topics vary with the field of specialization of visiting or regular faculty.

ECON 489-2 Advanced Topics in Economics (1 Unit)
Topics vary with the field of specialization of visiting or regular faculty.

ECON 490-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS Permission of instructor and department required. May be repeated for credit.

ECON 501-0 Graduate Student Seminar (1 Unit)
Student presentations of research papers. Primarily aimed at third year students.

ECON 515-0 Research Seminar in Economic Theory (1 Unit)
Open to advanced graduate students with research interests in economic theory.

ECON 519-0 Responsible Conduct of Research Training (0 Unit)

ECON 520-0 Research Seminar in Economic History (1 Unit)
Open to advanced graduate students with research interests in economic history.

ECON 530-0 Research Seminar in Macroeconomics (1 Unit)
Open to advanced graduate students with research interests in macroeconomics.

ECON 535-0 Research Seminar in Applied Microeconometrics (1 Unit)
Open to graduate students with research interests in labor, public finance, health care, education and development economics.
ECON 536-0 Research Seminar in Public Finance (1 Unit)
Open to advanced graduate students with research interests in public finance.

ECON 540-0 Research Seminar in Labor Economics (1 Unit)
Open to advanced graduate students with research interests in labor economics.

ECON 550-0 Research Seminar in Industrial Organization (1 Unit)
Open to advanced graduate students engaged in research on industry or labor market organization, prices or wages, and the regulation of collective bargaining, competition, or specific industries.

ECON 560-0 Research Seminar in Development and Trade (1 Unit)
Open to advanced graduate students with research interests in international economics.

ECON 580-0 Research Seminar in Econometrics (1 Unit)
Open to advanced graduate students with research interests in econometrics.

ECON 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Electrical Engineering (ELEC_ENG)

ELEC_ENG 307-0 Communications Systems (1 Unit)
Analysis of analog and digital communications systems, including modulation, transmission, and demodulation of AM, FM, and TV systems. Design issues, channel distortion and loss, bandwidth limitations, additive noise.
Prerequisites: ELEC_ENG 222-0, ELEC_ENG 302-0 or equivalent.

ELEC_ENG 308-0 Advanced Electromagnetics and Photonics (1 Unit)
Electromagnetic waves, transmission lines; impedance transformation; transients on lines; electrostatics, conductors, and capacitors; magnetostatics and inductors; wave reflection and transmission; electromagnetic motor, Maxwell's equations; metallic waveguides and wave transmission; antenna and diffraction, antenna arrays, communication, and radar.
Prerequisite: ELEC_ENG 224-0.

ELEC_ENG 326-0 Electronic System Design I (1 Unit)
This fast-paced course teaches students how to go from a project idea to a fully functional prototype implementation. This involves a printed circuit board design using PCB CAD software, surface mount soldering, MCU programming, CAD design for 3D printing, and web design.
Prerequisites: ELEC_ENG 221-0 and ELEC_ENG 225-0 and COMP_SCI 211-0, or graduate standing, or instructor consent.

ELEC_ENG 327-0 Electronic System Design II: Project (1 Unit)
This course puts to practice the knowledge gained in Electronic System Design I, and have students create a fully functional prototype implementation. This involves the same principles as in Electronic System Design I, but more independently, and with some design optimization. The course will also focus on team management and presentation skills, culminating in a project fair to the public. For a student with senior standing, this course can count towards the Design Degree Requirement in EE.
Prerequisite: ELEC_ENG 326-0 or instructor consent.

ELEC_ENG 332-0 Introduction to Computer Vision (1 Unit)
Computer and biological vision systems, image formation, edge detection, image segmentation, texture, representation and analysis of two-dimensional geometric structures and of three-dimensional structures.
Prerequisites: COMP_SCI 214-0, ELEC_ENG 222-0, and ELEC_ENG 302-0 or its equivalent.

ELEC_ENG 333-0 Introduction to Communication Networks (1 Unit)
Prerequisite: ELEC_ENG 302-0 or equivalent.

ELEC_ENG 353-0 Digital Microelectronics (1 Unit)
Logic families, comparators, A/D and D/A converters, combinational systems, sequential systems, solid-state memory, largescale integrated circuits, and design of electronic systems.
Prerequisites: COMP_ENG 203-0, ELEC_ENG 225-0.

ELEC_ENG 359-0 Digital Signal Processing (1 Unit)
Discrete-time signals and systems. Discrete-time Fourier transform, z-transform, discrete Fourier transform, digital filters.
Prerequisite: ELEC_ENG 222-0.

ELEC_ENG 360-0 Introduction to Feedback Systems (1 Unit)
Linear feedback control systems, their physical behavior, dynamical analysis, and stability. Laplace transform, frequency spectrum, and root locus methods. System design and compensation using PID and lead-lag controllers. Digital implementations of analog controllers.
Prerequisite: ELEC_ENG 222-0 or MECH_ENG 390-0 or BMD_ENG 306-0 or equivalent.

ELEC_ENG 363-0 Digital Filtering (1 Unit)
Recursive and nonrecursive digital filters, decimation and interpolation, A/D and D/A conversion as digital filtering problems. Implementation of nonrecursive filters via FFT, quantization problems (e.g., companding and limit cycles).
Prerequisite: ELEC_ENG 359-0.

ELEC_ENG 374-0 Introduction to Digital Control (1 Unit)
Discrete dynamics systems; discrete models of continuous systems feedback and digital controllers; analog-digital conversion; digital control design including PID, lead-lag, deadbeat, and mode-matching controllers.
Prerequisite: ELEC_ENG 360-0.

ELEC_ENG 378-0 Digital Communications (1 Unit)
Sampling and time-division multiplexing, baseband digital signals and systems. Coded pulse modulation, error control coding, digital modulation systems, information measure and source encoding, and introduction to spread spectrum communications.
Prerequisite: ELEC_ENG 302-0 or equivalent.

ELEC_ENG 379-0 Lasers and Coherent Optics (1 Unit)
Optical resonators; fundamental operation of lasers; mode-locking and Q-switching; optical propagation and diffraction; Gaussian beams; thin-lens imaging; optical signal processing.

ELEC_ENG 380-0 Wireless Communications (1 Unit)
Overview of existing and emerging wireless communications systems; interference, blocking, and spectral efficiency; radio propagation and fading models; performance of digital modulation in the presence of fading; diversity techniques; code-division multiple access.
Prerequisite: ELEC_ENG 378-0.

ELEC_ENG 381-0 Electronic Properties of Materials (1 Unit)
Prerequisite: ELEC_ENG 223-0 or consent of instructor.
ELEC_ENG 382-0 Photonic Information Processing (1 Unit)
Introduction to photonic information processing; coherent and incoherent light; electro-optic and acousto-optic modulation; optical signal processing; holography; optical storage. Prerequisites: ELEC_ENG 222-0 and ELEC_ENG 224-0 or consent of instructor.

ELEC_ENG 383-0 Fiber-Optic Communications (1 Unit)
Semiconductor diode lasers, internal modulation, electro-optic modulation, coherent and incoherent detection, optical fibers and their properties, optical amplifiers, communication systems, optical networks. Prerequisites: ELEC_ENG 223-0, ELEC_ENG 224-0.

ELEC_ENG 384-0 Solid State Electronic Devices (1 Unit)
Energy-band model for semiconductors; carrier statistics and transport; diodes, bipolar and field-effect transistors; integrated circuits, optoelectronic and heterojunction devices. Prerequisite: ELEC_ENG 381-0 or consent of instructor.

ELEC_ENG 385-0 Optoelectronics (1 Unit)
Introduction to solid-state optoelectronic devices; display devices, laser diodes, photodetectors, and light modulators; optical waveguides and fibers; system application of optoelectronic devices. Prerequisite: ELEC_ENG 381-0 or consent of instructor.

ELEC_ENG 386-0 Computational Electromagnetics and Photonics (1 Unit)
Introduction to the finite-difference time-domain (FDTD) method in numerical modeling of electromagnetic and optical wave interactions with engineering structures. Finite differences; Maxwell's equations; numerical dispersion and stability; free-space and waveguide field sources; absorbing boundary conditions; material dispersions and nonlinearities; modeling examples in modern electromagnetic and optical engineering. Prerequisite: ELEC_ENG 308-0.

ELEC_ENG 388-0 Nanotechnology (1 Unit)
Physics and fabrication of photonic and electronic devices. Physics of semiconductors: crystal structures, reciprocal lattice, elements of quantum mechanics, heterojunctions, quantum wells, and superlattices. Bulk crystal, thin-film, and epitaxial growth technologies. Device processing technologies: diffusion oxidation, ion implantation, annealing, etching, and photolithography. Prerequisite: ELEC_ENG 223-0 or consent of instructor.

ELEC_ENG 389-0 Superconductivity and Its Applications (1 Unit)
Properties of materials in the superconducting state; charge flow dynamics of type I superconductors; highTc superconductors; applications for computers and high-frequency devices. Prerequisite: ELEC_ENG 381-0 or consent of instructor.

ELEC_ENG 390-0 Introduction to Robotics (1 Unit)
Homogeneous vectors and planes; homogeneous transformation, position and orientation transformations, kinematics and inverse kinematic solutions of robot manipulators; Jacobian and inverse Jacobian relation; robot trajectory and task planning; dynamic formulation and computation of robot manipulators; robot programming and control systems. Prerequisite: COMP_SCI 230-0.

ELEC_ENG 395-0 Special Topics in Electrical Engineering (1 Unit)
Topics suggested by students or faculty and approved by the department.

ELEC_ENG 401-0 Fundamentals of Electronic Devices (1 Unit)
Transport phenomena in semiconductors, theory of the p-n junction, bipolar and unipolar devices, general analysis of the metal-semiconductor and MIS structures, CCD, and MOSFET and biopolar transistors. Prerequisite: ELEC_ENG 381-0 or ELEC_ENG 388-0.

ELEC_ENG 402-0 Advanced Electronic Devices (1 Unit)
Semiconductor optics, heterojunctions, quantum wells, superlattices, and resonant tunneling. Field-effect and potential-effect devices. Hot-electron devices. Microwave devices. Prerequisite: ELEC_ENG 381-0 or ELEC_ENG 384-0.

ELEC_ENG 403-0 Quantum Semiconductors (1 Unit)
Elements of wave mechanics necessary to explain band theory. Fermi-Dirac statistics, introduction to the theory of electrical conductivity in semiconductors, optical and thermal properties, diffusion of electrons, and holes in solids. Prerequisite: ELEC_ENG 381-0.

ELEC_ENG 404-0 Quantum Electronics (1 Unit)

ELEC_ENG 405-0 Advanced Photonics (1 Unit)
Physical description of compound semiconductors; optical properties of heterostructures, quantum wells, superlattices, quantum wires and quantum dots; physics and technology of optoelectronic devices; light emitting diodes (LEDs) and lasers. Prerequisite: ELEC_ENG 381-0 or ELEC_ENG 401-0.

ELEC_ENG 406-0 Nonlinear Optics (1 Unit)
Nonlinear optical susceptibilities; wave propagation and coupling in nonlinear media; harmonic, sum, and difference frequency generation; parametric amplification and oscillation; phase-conjugation via four-wave mixing; self-phase modulation and solitons. Prerequisites: ELEC_ENG 382-0 and ELEC_ENG 404-0 or permission of instructor.

ELEC_ENG 407-0 Quantum Optics (1 Unit)
Review of quantum fields; quantization of the electromagnetic field; photodetection theory; direct, homodyne, and heterodyne detection; squeezed and photon-number state generation; application to optical communication and interferometers. Prerequisites: ELEC_ENG 404-0 and ELEC_ENG 406-0 or permission of instructor.

ELEC_ENG 408-1 Classical Electodynamics (1 Unit)
Introduction to classical analytical techniques for static and dynamic electromagnetic fields. Static electric field and scalar potential; multipole expansions of the scalar potential; magnetostatics and the vector potential; time-varying fields; Maxwell's equations; Coulomb and Lorentz gauge; Green's functions for the wave equation; use of the causal Green's function for electromagnetic radiation; multipole expansions of the radiating field; application to simple antennas. Prerequisite: ELEC_ENG 308-0.

ELEC_ENG 408-2 Computational Electrodynamics (1 Unit)
Advanced topics in the finite-difference time-domain (FDTD) method for numerical modeling of electromagnetic wave interactions with engineering structures. Reduced-numerical-dispersion algorithms employing fourth-order spatial differencing; uniaxial perfectly matched layer absorbing boundary conditions; generalized grids; incorporation of lumped-circuit elements. Prerequisite: ELEC_ENG 386-0.

ELEC_ENG 409-0 Semiconductor Lasers (1 Unit)
Basic concepts of lasers; laser applications; gas and liquid lasers; solid-state lasers; semiconductor lasers; materials and devices; rate equations;
laser gain and saturation; modulation and light pulse generation; advanced technology for semiconductor laser fabrication and integration; industrial and medical applications of laser diodes. 
Prerequisite: ELEC_ENG 403-0 or ELEC_ENG 405-0.

ELEC_ENG 410-0 System Theory (1 Unit)
Unified treatment of continuous and discrete time systems from a state-variable viewpoint; emphasis on linear systems. Concept of state, writing and solving state equations, controllability and observability, transform techniques (Fourier, Laplace, Z), stability, and Lyapunov's method. 
Prerequisite: ELEC_ENG 360-0.

ELEC_ENG 411-0 Fundamentals and Applications of Special Relativity (1 Unit)
This course will introduce students to Special Relativity (SR), illustrate the relation between SR and Maxwell's Equations, and explain the origin of magnetic fields and forces. In addition, it will describe quantitatively the role of SR in modern optical devices and systems such as Sagnac interferometers, gyrosopes, free electron lasers, clocks and the global positioning system. The origin of electron spin and the Pauli exclusion principle based on SR will also be discussed.

ELEC_ENG 414-0 Advanced Topics in Quantum Electronics (1 Unit)
Study of advanced topics of current interest in the field of quantum electronics, with an emphasis on atom-laser interaction. Selected topics from the following areas will be covered, with an emphasis on practical applications: Review of Atomic Transitions, Semi-Classical Atom-Laser Interaction, Quantized Radiation Field, Cavity Quantum Electrodynamics, Fundamental Formalisms in Quantum Noise, Quantum Theory of Spontaneous Emission, and Quantum Theory of Laser.

ELEC_ENG 418-0 Advanced Digital Signal Processing (1 Unit)
Selected topics in digital signal processing such as digital speech processing, multidimensional digital signal processing, spectrum estimation, and error analysis.
Prerequisite: ELEC_ENG 359-0.

ELEC_ENG 420-0 Digital Image Processing (1 Unit)
Prerequisite: ELEC_ENG 359-0 or equivalent.

ELEC_ENG 421-0 Multimedia Signal Processing (1 Unit)
Fundamentals of applying digital signal processing to speech signals. Topics include models of speech production and hearing and synthesis methods and applications.
Prerequisite: ELEC_ENG 359-0.

ELEC_ENG 422-0 Random Processes in Communications and Control 1 (1 Unit)
Fundamentals of random variables; mean-squared estimation; limit theorems and convergence; definition of random processes; autocorrelation and stationarity; Gaussian and Poisson processes; Markov chains.
Prerequisite: One course in probability.

ELEC_ENG 423-0 Random Processes in Communications and Control 2 (1 Unit)
Prerequisite: ELEC_ENG 422-0.

ELEC_ENG 424-0 Distributed Optimization (1 Unit)
This course studies various models and algorithms in the distributed and parallel settings. Topics include graph theory, algorithms for solving linear equations, iterative methods for convex problems, synchronous and asynchronous setups, consensus algorithms and rate analysis.

ELEC_ENG 425-0 Introduction to Nanoscale Lasers, Quantum Noise, Photons, and Measurement (1 Unit)
Introduction to semiclassical theory of lasers leading to coherent, noise, and modulation properties of lasers, with emphasis on semiconductor lasers. Includes topics on noise in optical amplifiers and effects of optical feedback on lasers. Quantum theory of lasers is introduced, leading to topics on quantum states of laser light.
Prerequisite: ELEC_ENG 404-0 or permission of instructor.

ELEC_ENG 426-0 Signal Detection and Estimation (1 Unit)
Simple-hypothesis detection problems, detection of signals with unknown parameters, Bays' maximum likelihood estimation, estimation of signal parameters, detection of stochastic signals, nonparametric detection and estimation.
Prerequisites: ELEC_ENG 307-0 and ELEC_ENG 422-0.

ELEC_ENG 427-0 Optical Communications (1 Unit)
Optical communication systems, optical wave propagation, photodetection statistics, heterodyne receiver, and noise sources. Evaluation of communication performance for the free-space channel. Introduction to fiber optic communication and fiber optic networks.
Prerequisites: ELEC_ENG 307-0 and probability.

ELEC_ENG 428-0 Information Theory (1 Unit)
Information measures and their properties: entropy, divergence, mutual information, channel capacity. Shannon's fundamental theorems for data compression and coding for noisy channels. Applications in communications, statistical inference, algorithmic complexity, probability and finance.
Prerequisite: ELEC_ENG 302-0.

ELEC_ENG 429-0 Selected Topics in Quantum Information Science and Technology (1 Unit)
Basic general principles of quantum mechanics for applications to quantum information science and technology. The fundamentals will be covered, together with topics of current interest among the areas of quantum teleportation, quantum computation, and quantum cryptography.
Prerequisites: Knowledge of quantum mechanics and permission of instructor.

ELEC_ENG 432-0 Advanced Computer Vision (1 Unit)
Fundamental and advanced topics in statistical pattern recognition including Bayesian decision theory, Maximum-likelihood and Bayesian estimation, Nonparametric density estimation, Component Analysis and Discriminants, Kernel machines, Feature selection, dimension reduction and embedding, Boosting, Minimum description length, Mixture models and clustering, Spectral clustering, Bayesian network and Hidden Markov models, with the applications to image and video pattern recognition.

ELEC_ENG 435-0 Deep Learning: FAA (1 Unit)
The course covers the fundamentals of deep learning and numerical optimization, with many application examples.

ELEC_ENG 436-0 Advanced Communication Networks (1 Unit)
Basic techniques for modeling and analyzing data communication networks. Protocol specification and correctness, queueing models, loss networks, multi-class queues and scheduling, graph-based and flow-based routing, congestion control and pricing.
Prerequisites: ELEC_ENG 302-0; ELEC_ENG 333-0 helpful but not required.
Engineering Science & Applied Math (ES_APPM)

ES_APPM 311-1 Methods of Applied Mathematics (1 Unit)
Ordinary differential equations; Sturm-Liouville theory, properties of special functions, solution methods including Laplace transforms. Fourier series: eigenvalue problems and expansions in orthogonal functions. Partial differential equations: classification, separation of variables, solution by series and transform methods. Prerequisite: GEN_ENG 205-4, GEN_ENG 206-4, or MATH 250-0.

ES_APPM 311-2 Methods of Applied Mathematics (1 Unit)
Ordinary differential equations; Sturm-Liouville theory, properties of special functions, solution methods including Laplace transforms. Fourier series: eigenvalue problems and expansions in orthogonal functions. Partial differential equations: classification, separation of variables, solution by series and transform methods. Prerequisite: GEN_ENG 205-4, GEN_ENG 206-4, or MATH 250-0.

ES_APPM 312-0 Complex Variables (1 Unit)
Imaginary numbers and complex variables, analytic functions, calculus of complex functions, contour integration with application to transform inversion, conformal mapping. Prerequisite: GEN_ENG 205-4, GEN_ENG 206-4, or MATH 250-0.

ES_APPM 322-0 Applied Dynamical Systems (1 Unit)
Example-oriented survey of nonlinear dynamical systems, including chaos. Combines numerical exploration of differential equations describing physical problems with analytic methods and geometric concepts. Applications to mechanical, fluid dynamical, electrical, chemical, and biological systems. Prerequisites: ES_APPM 311-1 and ES_APPM 311-2 or equivalent or consent of instructor.

ES_APPM 345-0 Applied Linear Algebra (1 Unit)
Understanding and implementation of algorithms to calculate matrix decompositions such as eigenvalue/vector, LU, QR, and SVD decompositions. Applications include data-fitting, image analysis, and ranking algorithms.

ES_APPM 346-0 Modeling and Computation in Science & Engineering (1 Unit)
Advanced techniques for initial value problems, differential algebraic systems, bifurcations, chaos, and partial differential equations. Applications drawn from different physical areas. Prerequisites: MATH 234-0, MATH 240-0, and MATH 250-0; or GEN_ENG 205-4 and PHYSICS 135-1, PHYSICS 135-2; or equivalent; familiarity with a programming language; or consent of instructor.

ES_APPM 370-1 Introduction to Computational Neuroscience (1 Unit)

ES_APPM 375-1 Quantitative Biology I: Experiments, Data, Models, and Analysis (1 Unit)
High-resolution, high-throughput, and dynamic imaging and sequencing data is the substrate of modern biology. The course consists of case-studies where we learn how to computational work with, analyze, and make sense of experimental dataset using fundamental principles of mathematics, statistics, and physics. No formal course. Prerequisites. Programming in python.

ES_APPM 375-2 Quantitative Biology II: Experiments, Data, Models, and Analysis (1 Unit)
High-resolution, high-throughput, and dynamic imaging and sequencing data is the substrate of modern biology. In this course we learn how to perform experiments, and computational work with, analyze, and make sense of experimental dataset using fundamental principles of mathematics, statistics, and physics. No formal course. Prerequisites. Programming in python.

ES_APPM 395-0 Special Topics (1 Unit)
This is a seminar course where ESAM faculty present their current and planned research topics in applied mathematics.

ES_APPM 401-0 Options Pricing: Theory and Applications (1 Unit)
Consideration of ordinary and elementary partial differential equations models of problems in science and engineering, arising in various areas of application. Prerequisites: Permission of instructor and department.

ES_APPM 411-1 Differential Equations of Mathematical Physics (1 Unit)

ES_APPM 411-2 Differential Equations of Mathematical Physics (1 Unit)

ES_APPM 411-3 Differential Equations of Mathematical Physics (1 Unit)

ES_APPM 412-0 Methods of Nonlinear Analysis (1 Unit)

**ES_APPM 420-1 Asymptotic and Perturbation Methods in Applied Mathematics (1 Unit)**

**ES_APPM 420-2 Asymptotic and Perturbation Methods in Applied Mathematics (1 Unit)**

**ES_APPM 420-3 Asymptotic and Perturbation Methods in Applied Mathematics (1 Unit)**

**ES_APPM 421-1 Models in Applied Mathematics (1 Unit)**
Applications to illustrate typical problems and methods of applied mathematics. Mathematical formulation of models for phenomena in science and engineering, problem solution, and interpretation of results. Examples from solid and fluid mechanics, combustion, diffusion phenomena, chemical and nuclear reactors, and biological processes.

**ES_APPM 426-0 Theory of Flows With Small Inertia (1 Unit)**
Asymptotic methods for flows with small inertia: flows past bodies and matching procedures. Slowly varying flows: lubrication theory and Helle-Shaw flow; swimming of microorganisms and suspension of particles.

**ES_APPM 429-0 Hydrodynamic Stability Theory (1 Unit)**
Mathematical theory of hydrodynamic states; energy methods, linear theories, and nonlinear bifurcation theories. Convective, centrifugal, and shear flow instabilities. Instability of unsteady flows and systems having interfaces. Physical mechanisms and results of experiments.

**ES_APPM 430-0 Wave Propagation (1 Unit)**

**ES_APPM 440-0 Integral Equations & Applications (1 Unit)**

**ES_APPM 442-0 Stochastic Differential Equations (1 Unit)**
Brownian motion and Langevin’s equation. Ito and Stratonovich stochastic integrals. Stochastic calculus and Ito’s formula. SDEs and PDEs of Kolmogorov, Fokker-Planck, and Dynkin. Boundary conditions, exit times, exit distributions, stability. Asymptotic analysis of SDE, the Smoluchowski-Kramers approximation, and diffusion approximation to Markov chains. Applications.

**ES_APPM 444-0 High Performance Scientific Computing (1 Unit)**
Solving partial differential equations using high performance computing platforms. Basic C programming. Distributed computing using MPI. GPU programming using CUDA. Adaptation of algorithms for solving PDE’s to different architectures.

**ES_APPM 445-0 Iterative Methods for Elliptic Equations (1 Unit)**
Analysis and application of numerical methods for solving elliptic equations. Stationary iterative, multigrid, conjugate gradient, GMRES methods and preconditioners.

**ES_APPM 446-1 Numerical Solution of Partial Differential Equations (1 Unit)**

**ES_APPM 446-2 Numerical Solution of Partial Differential Equations (1 Unit)**

**ES_APPM 447-0 Boundary Integral Method (1 Unit)**

**ES_APPM 448-0 Numerical Methods for Random Processes (1 Unit)**
Analysis and implementation of numerical methods for random processes: random number generators, Monte Carlo methods, Markov chains, stochastic differential equations, and applications.

**ES_APPM 449-0 Numerical Methods for Moving Interfaces (1 Unit)**
Methods for simulating sharp interfaces. Marker particle, level set, fast marching, volume of fluid, and phase fields methods.

**ES_APPM 495-0 Selected Topics in Applied Mathematics (0.5-1 Unit)**
Topics selected from research of current interest in applied mathematics.

**ES_APPM 499-0 Projects (1 Unit)**
Special projects to be carried out under faculty direction. Permission of instructor and department required.

**ES_APPM 519-0 Responsible Conduct of Research Training (0 Unit)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**English (ENGLISH)**

**ENGLISH 302-0 History of the English Language (1 Unit)**
The English language from the earliest times to today. Historical Studies Distro Area Interdisciplinary Distro - See Rules (https://catalogs.northwestern.edu/undergraduate/arts-sciences/#schoolrequirementstext) Literature Fine Arts Distro Area

**ENGLISH 310-0 Studies in Literary Genres (1 Unit)**
Content varies. May be repeated for credit with different topic. Literature Fine Arts Distro Area

**ENGLISH 311-0 Studies in Poetry (1 Unit)**
Content varies. May be repeated for credit with different topic. Literature Fine Arts Distro Area

**ENGLISH 312-0 Studies in Drama (1 Unit)**
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Literature Fine Arts Distro Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGLISH 313-0</td>
<td>Studies in Fiction (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 320-0</td>
<td>Medieval English Literature (1 Unit)</td>
<td>Representative works in their intellectual and cultural contexts.</td>
</tr>
<tr>
<td>ENGLISH 322-0</td>
<td>Medieval Drama (1 Unit)</td>
<td>Study of 15th century English mystery cycles, miracle plays, and morality plays in their cultural context.</td>
</tr>
<tr>
<td>ENGLISH 323-1</td>
<td>Chaucer (1 Unit)</td>
<td>&quot;The Canterbury Tales.&quot;</td>
</tr>
<tr>
<td>ENGLISH 324-0</td>
<td>Studies in Medieval Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 331-0</td>
<td>Renaissance Poetry (1 Unit)</td>
<td>English poetry from the Elizabethan period to 1660.</td>
</tr>
<tr>
<td>ENGLISH 332-0</td>
<td>Renaissance Drama (1 Unit)</td>
<td>A survey of English drama (1590-1630) and its cultural contexts.</td>
</tr>
<tr>
<td>ENGLISH 334-1</td>
<td>Shakespeare (1 Unit)</td>
<td>Principal plays up to 1600.</td>
</tr>
<tr>
<td>ENGLISH 334-2</td>
<td>Shakespeare (1 Unit)</td>
<td>Principal plays after 1600.</td>
</tr>
<tr>
<td>ENGLISH 335-0</td>
<td>Milton (1 Unit)</td>
<td>Milton’s poetry, with those parts of his prose that illuminate his poetical and intellectual development.</td>
</tr>
<tr>
<td>ENGLISH 338-0</td>
<td>Studies in Renaissance Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 339-0</td>
<td>Special Topics in Shakespeare (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 340-0</td>
<td>Restoration and 18th Century Literature (1 Unit)</td>
<td>Representative works in their intellectual and cultural contexts.</td>
</tr>
<tr>
<td>ENGLISH 341-0</td>
<td>Restoration and 18th Century Poetry (1 Unit)</td>
<td>Dryden, Pope, and other poets of the period 1660-1744.</td>
</tr>
<tr>
<td>ENGLISH 342-0</td>
<td>Restoration and 18th-Century Drama (1 Unit)</td>
<td>English drama from 1660 to the end of the 18th century.</td>
</tr>
<tr>
<td>ENGLISH 344-0</td>
<td>18th-Century Fiction (1 Unit)</td>
<td>Writers such as Defoe, Richardson, Smollett, Fielding, Sterne, Burney, Radcliffe, and Austen. Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 345-0</td>
<td>Victorian Poetry (1 Unit)</td>
<td>The principal British poets from Tennyson to Hopkins.</td>
</tr>
<tr>
<td>ENGLISH 348-0</td>
<td>Studies in Restoration and 18th-Century Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 350-0</td>
<td>19th-Century British Literature (1 Unit)</td>
<td>Representative works in their intellectual and cultural contexts.</td>
</tr>
<tr>
<td>ENGLISH 351-0</td>
<td>Romantic Poetry (1 Unit)</td>
<td>Writers such as Blake, Wordsworth, Coleridge, Byron, Shelley, and Keats.</td>
</tr>
<tr>
<td>ENGLISH 352-0</td>
<td>19th Century Fiction (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 353-0</td>
<td>Studies in Victorian Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 356-0</td>
<td>Victorian Poetry (1 Unit)</td>
<td>Representative works of Charles Dickens.</td>
</tr>
<tr>
<td>ENGLISH 357-0</td>
<td>19th-Century British Fiction (1 Unit)</td>
<td>Representative novels written between 1800 and 1900.</td>
</tr>
<tr>
<td>ENGLISH 358-0</td>
<td>Dickens (1 Unit)</td>
<td>Representative works of Charles Dickens.</td>
</tr>
<tr>
<td>ENGLISH 359-0</td>
<td>Studies in Victorian Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 360-0</td>
<td>20th-Century British and American Literature (1 Unit)</td>
<td>Representative works in their intellectual and cultural contexts.</td>
</tr>
<tr>
<td>ENGLISH 361-1</td>
<td>20th-Century Poetry (1 Unit)</td>
<td>First Quarter: Major British poets such as Yeats, Eliot, and Auden.</td>
</tr>
<tr>
<td>ENGLISH 361-2</td>
<td>20th-Century Poetry (1 Unit)</td>
<td>Second Quarter: Major American poets from Frost and Robinson to Crane.</td>
</tr>
<tr>
<td>ENGLISH 361-3</td>
<td>20th-Century Poetry (1 Unit)</td>
<td>Third Quarter: British and American poetry since World War II.</td>
</tr>
<tr>
<td>ENGLISH 363-1</td>
<td>20th Century Fiction (1 Unit)</td>
<td>Major British novelists from Conrad to World War II.</td>
</tr>
<tr>
<td>ENGLISH 363-2</td>
<td>20th Century Fiction (1 Unit)</td>
<td>Major American novelists from James to World War II.</td>
</tr>
<tr>
<td>ENGLISH 365-0</td>
<td>Studies in Postcolonial Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 366-0</td>
<td>Studies in African American Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
<tr>
<td>ENGLISH 367-0</td>
<td>Postwar British Fiction (1 Unit)</td>
<td>Representative British novels since 1945.</td>
</tr>
<tr>
<td>ENGLISH 368-0</td>
<td>Studies in 20th-Century Literature (1 Unit)</td>
<td>Content varies. May be repeated for credit with different topic.</td>
</tr>
</tbody>
</table>
ENGLISH 369-0 Studies in African Literature (1 Unit)
20th century African literature in English. Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 370-0 American Literature Before 1914 (1 Unit)
Representative works in their intellectual and cultural contexts.
Literature Fine Arts Distro Area

ENGLISH 371-0 American Novel (1 Unit)
Writers such as Cooper, Alcott, Chopin, Hawthorne, Melville, Poe, Twain, James, Howells, Crane, Dreiser, and Wharton. Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 372-0 American Poetry (1 Unit)
Writers such as Freneau, Bradstreet, Bryant, Poe, Whitman, Dickinson, Robinson, and Frost. Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 374-0 Topics in Native American and Indigenous Literatures (1 Unit)
Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 378-0 Studies in American Literature (1 Unit)
Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 383-0 Special Topics in Theory (1 Unit)
Topics in theory and criticism related to the study of literature and culture. Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 385-0 Topics in Combined Studies (1 Unit)
Special topics in literature and related disciplines. Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 386-0 Studies in Literature and Film (1 Unit)
Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 387-0 Studies in Literature and Commerce (1 Unit)
Content varies. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

ENGLISH 397-0 Research Seminar for Literature Majors (1 Unit)
For juniors and seniors. Topics vary. Students research and complete an independent term paper related to the topic of the seminar.

ENGLISH 403-0 Writers’ Studies in Literature (1 Unit)
Writers’ Studies in Literature. Students will learn about literature from a writer’s perspective through close reading, as well as contextualization through generic, and thematic and formal lineage. Students will begin to see literature as a “body of enacted criticism” in a way that is essential to the program’s interdisciplinary foundation and to their own development as writers. These courses will be taught by either creative writing faculty or literature faculty, with at least one major assignment in each course relying on research and critical writing.

ENGLISH 410-0 Introduction to Graduate Study (1 Unit)
Principles, techniques, and consequences of representative modes of literary inquiry exemplified in works of contemporary scholarship and criticism. Required of Ph.D. students.

ENGLISH 411-0 Studies in Poetry (1 Unit)
Content varies. Topics may include prosody or other formal aspects of poetry; comparative study of poems from different historical periods; consideration of poetics and the relationship of poetry to other cultural activities.

ENGLISH 412-0 Studies in Drama (1 Unit)
Content varies. Samples: theories of comedy; the history play.

ENGLISH 413-0 Studies in the Novel (1 Unit)
Content varies. Samples: Richardson and Fielding; Gothic fiction; Dickens; theory of the novel from James to Kermode.

ENGLISH 422-0 Studies in Medieval Literature (1 Unit)
Literature of the medieval period, including, but not necessarily restricted to, literature written in Middle English.

ENGLISH 431-0 Studies in 16Th Century Literature (1 Unit)
Content varies. Samples: Elizabethan romance; Spenser; Sidney.

ENGLISH 434-0 Studies in Shakespeare (1 Unit)

ENGLISH 435-0 Studies in 17Th Century Literature (1 Unit)
Content varies. Samples: Donne’s poetry; Milton.

ENGLISH 441-0 18Th Cent Lit (1 Unit)
Content varies. Samples: Swift, Blake, and sensibility from Rousseau to Austen.

ENGLISH 451-0 Studies in Romantic Literature (1 Unit)
Content varies. Samples: the long poem in the Romantic period; Byron and the Byronic.

ENGLISH 455-0 Studies in Victorian Literature (1 Unit)
Content varies. Samples: Victorian poetics; biography and autobiography; Anglo-American literary relationships.

ENGLISH 461-0 Studies in Contemporary Literature (1 Unit)
Content varies. Samples: James Joyce; experiments in fiction.

ENGLISH 465-0 Studies in Colonial & Postcolonial Lit (1 Unit)
Content varies. Colonial and postcolonial literatures of Africa, Latin America, the Caribbean, and other formerly colonized cultures, with attention to theoretical accounts of colonial and postcolonial culture.

ENGLISH 471-0 Studies in American Literature (1 Unit)
Content varies. Samples: Henry James; historical backgrounds of colonial literature; Whitman.

ENGLISH 481-0 Studies in Literary Theory and Criticism (1 Unit)
Topics in literary theory and theories related to the study of Anglophone literature and culture, focusing on issues of methodology and interpretation. Content varies.

ENGLISH 490-0 Independent Reading (1 Unit)
Permission of department required. May be repeated for credit.

ENGLISH 491-0 Editorial Practicum (0 Unit)
Summer work as an editorial assistant for TriQuarterly Online. Open to students in the Litowitz Creative Writing Graduate Program, MFA+MA.

ENGLISH 493-0 Elements of Craft (1 Unit)
A cross-genre seminar-based workshop for first-year MFA+MA students. This course will prepare students for the dual-degree program and teach them the "language of workshop" while developing their critical and creative writing skills.

ENGLISH 494-0 Mapping the MFA Thesis (1 Unit)
The Long Form-MFA cross-genre workshop dedicated to organizing the MFA thesis.

ENGLISH 495-0 Cross-Genre Creative Writing Workshop (1 Unit)
Students will practice creative writing across genres and will examine the ways that genres overlap, influence and inform one another.

ENGLISH 496-0 MFA Poetry Workshop (1 Unit)
A graduate level poetry workshop for MFA+MA students. Open to other university graduate students by application.

ENGLISH 497-0 MFA Fiction Workshop (1 Unit)
A graduate level fiction workshop for MFA+MA students. Open to other university graduate students by application.

ENGLISH 498-0 MFA Creative Nonfiction Workshop (1 Unit)
A graduate level creative nonfiction workshop for MFA+MA students. Open to other university graduate students by application.

ENGLISH 499-0 Independent Study (1 Unit)
Permission of instructor and department required. May be repeated for credit.

ENGLISH 505-0 Research Development Seminar (1 Unit)
Third year doctoral students in the English department will be required to take this class in which they will draft a doctoral prospectus and an application for a research grant.

ENGLISH 520-0 Writing for Publication (1 Unit)
English department students in candidacy will develop professional skills related to writing for publication, whether for an academic or a broader public audience.

ENGLISH 570-0 Seminar in Teaching Composition (1 Unit)
An introduction to theories, practices and controversies in the teaching of writing in colleges and universities, within the context of various definitions of literacy in American culture.

ENGLISH 571-0 Teaching Creative Writing (1 Unit)
All MFA+MA students will take this specially designed pedagogy course during their first year. Students will study the history and models of teaching for Creative Writing programs. Students will design creative writing courses, set clear, achievable learning objectives, draft syllabi, generate exercises, and select reading material for introductory courses in poetry, fiction, and creative nonfiction.

ENGLISH 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS- Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

ENGLISH 591-0 MFA Thesis Tutorial (1-3 Units)
Registration for MFA+MA students writing an MFA Thesis project.

Environmental Policy & Culture (ENVR_POL)

ENVR_POL 390-0 Special Topics in Environmental Policy and Culture (1 Unit)
Lecture course on environmental issues of current interest to students and faculty. May be repeated for credit with different topic. Social Behavioral Sciences Distro Area

ENVR_POL 395-0 Special Topics Seminar (1 Unit)
Seminar on current environmental issues and problems. Topics vary. May be repeated for credit with different topic.

Epidemiology & Biostatistics (EPI_BIO)

EPI_BIO 301-0 Introduction to Epidemiology (1 Unit)
This course introduces epidemiology and its uses for population health research. Concepts include measures of disease occurrence, common sources and types of data, important study designs, sources of error in epidemiologic studies and epidemiologic methods.

EPI_BIO 302-0 Introduction to Biostatistics (1 Unit)
This course introduces principles of biostatistics and applications of statistical methods in health and medical research. Concepts include descriptive statistics, basic probability, probability distributions, estimation, hypothesis testing, correlation and simple linear regression.

EPI_BIO 303-0 Basic Probability (1 Unit)
This course introduces probability as the theoretical framework underlying statistical methods. Concepts include random variables, discrete and continuous probability distributions, multivariate distributions, and random variable transformations. A working knowledge of differential / integral calculus and matrix algebra fundamentals is required.

EPI_BIO 305-0 Applied Statistical Programming in SAS (1 Unit)
This course provides a thorough working introduction to the statistical programming language SAS. Concepts focus on practical issues relating to data management, statistical data processing and SAS programming.

EPI_BIO 306-0 R Programming (1 Unit)
This course provides a thorough working introduction to the statistical programming language R. Concepts focus on practical issues including: installing and configuring the RStudio development environment; loading and managing data in R; accessing R packages; writing R functions; writing R scripts; debugging and profiling R scripts; organizing and commenting R code; and developing dynamic analysis reports using R Markdown. Topics in biostatistical data analysis will provide relevant working examples.

EPI_BIO 401-0 Intermediate Epidemiology (1 Unit)
The purpose of this course is twofold: 1) To elaborate on concepts first introduced in introductory epi and demonstrate to students how these concepts are frequently in applied in biomedical literature; and 2) To provide students an overview of the physiology, pathophysiology, and epidemiology of prevalent diseases in the United States. Prerequisite: EPI_BIO 301-0, EPI_BIO 302-0 or PUB_HLTH 302-0.

EPI_BIO 402-0 Intermediate Biostatistics (1 Unit)
This course provides an intermediate-level treatment of linear and logistic regression models, including model estimation and inference, model building and diagnostics, and interpretation of results in the context of epidemiologic and clinical studies. The focus is on practical application of regression models for data analysis. The course uses R statistical software for data analysis.

EPI_BIO 403-0 Statistical Inference and Applied Techniques (1 Unit)
This course introduces statistical inference concepts and applied statistical techniques for data analysis in a mathematical framework. Concepts include point and interval estimation, maximum likelihood, large sample theory, hypothesis testing, bootstrap methods, analysis of variance, linear regression, analysis of categorical data and Bayesian methods.

EPI_BIO 427-0 Practical Issues in Population Studies (0.5 Unit)
This course covers practical aspects of conducting a population-based research study. Concepts include determining a study budget, setting a timeline, identifying study team members, setting a strategy for recruitment and retention, developing a data collection protocol and monitoring data collection to ensure quality control and quality assurance. Students will demonstrate these skills by engaging in a quarter-long group project to draft a Manual of Operations for a new "mock" population study.
EPI_BIO 429-0 Systematic Review and Meta-Analysis in the Medical Sciences (1 Unit)
This course covers statistical methods for meta-analysis. Concepts include fixed-effects and random-effects models, measures of heterogeneity, prediction intervals, meta regression, power assessment, subgroup analysis and assessment of publication bias. The course will emphasize basic theory and underlying statistical methods, computational approaches and interpretation of results from published studies.

EPI_BIO 445-0 Data Science for Clinical, Translational, and Population Researchers (1 Unit)
Due to advances in technology and data collection, the ability to analyze complex data sets is a necessary skill for all clinical, translational and population researchers. A variety of data analysis tools exist, some unique to specific domains. This course provides an introduction to the data, analysis tools, ethical considerations, and terminologies from across biomedical data science with an emphasis on clinical, translational and population methods and tools.

EPI_BIO 446-0 Design, Conduct, and Analysis of Clinical Trials (1 Unit)
This is an Introduction to clinical trials, including design, conduct, analysis and interpretation of trial results. Topics include trial design, methods for randomization, blinding and sample size determination, choice of controls, operational issues, data management and data quality issues, interim analysis methods, critical review of clinical trial proposals and published results and statistical techniques for analyzing clinical trial data.

EPI_BIO 499-0 Independent Study (0.5-1 Unit)
This is Independent Study course is designed to give students a hands-on practical training on statistical analysis. This course will offer 4 statistical consultation projects -- real case study. Students will be given the data and a brief introduction of the data. Students will need to check the data, perform preliminary data analysis, orally present their statistical approach, modeling, findings, and interpretation of their result, and write a report for each project. Students will be evaluated by the quality of their oral presentation and project report.

EPI_BIO 501-0 Advanced Epidemiology (1 Unit)
This course builds on material learned in previous Biostatistics and Epidemiology courses. Concepts are applied to the design, implementation, analysis and interpretation of observational epidemiologic studies (cross-sectional, case-control and cohort). Students enrolled in an MPH degree program must have the consent of the instructor.
Prerequisites: EPL_BIO 301-0, EPL_BIO 302-0, EPL_BIO 401-0, EPL_BIO 402-0.

EPI_BIO 502-0 Advanced Biostatistics (1 Unit)
This course covers modern approaches to the analysis of correlated response data arising from longitudinal studies commonly encountered in medical research and clinical trials. Concepts include marginal and mixed-effects regression models for continuous and discrete outcomes measured repeatedly over time, model building techniques, robust inference procedures and problems associated with missing data. All modeling and numerical analyses will be done using SAS. Prerequisites include the equivalent of EPL_BIO 302-0, EPL_BIO 402-0.

EPI_BIO 521-0 Applied Survival Data Analysis (1 Unit)
This course provides an introduction to the fundamental concepts and methods developed for analysis of survival data for which incompleteness, including censoring, is a primary feature. Classic non-parametric estimation approaches will be discussed, as will semi-parametric and parametric hazard regression modeling techniques that allow incorporation of covariates. Analysis examples using both R and SAS will be discussed.

EPI_BIO 527-0 Statistical Methods for Missing Data (0.5 Unit)
This course provides students with a basic knowledge of the potential implications of missing data on their data analyses as well as potential solutions. A major focus of the course is multiple imputation including discussions of the general framework, different models and algorithms, and the basic theory. Statistical programming is performed in R.

EPI_BIO 529-0 Statistical Genetics (0.5 Unit)
This course equips students with key principles and practical skills to analyze genetic data. Topics range from linkage analysis using pedigree data to machine learning techniques using next-generation sequencing data. Statistical programming is performed in R.

EPI_BIO 560-0 Statistical Consulting (0.5 Unit)
This course prepares students for collaboration and communication with scientists of various disciplines, emphasizing analytical tools, verbal and written communication skills and presentation skills. Concepts include sample size and power calculation, handling of various data structures, data presentation, selecting appropriate statistical methods, time and project management, reproducible research, report writing and grant writing.

EPI_BIO 561-0 Thesis (0.5 Unit)
All MS in Biostatistics students are required to submit a master’s thesis focusing on a collaborative data analysis or a statistical methodology advancement. Thesis projects are proposed in the fall, and content is developed primarily in late fall / winter. Written, poster and oral presentations are due in the spring.

EPI_BIO 565-0 Clinical Database Management (0.5 Unit)
This course serves as an introduction to data management in the clinical research setting. The Research Electronic Data Capture (REDCap) platform is used to understand basic database design, data management and quality monitoring concepts for studies ranging from simple cross-sectional designs to complex multi-center clinical trials.

Finance (FINC)

FINC 499-0 Independent Study (1 Unit)
Students who have established superior records and wish to study some significant phase of finance in more depth than is provided in regular courses may register for independent study with a selected instructor. Permission of the instructor and department are required.

FINC 520-1 Time Series Analysis (1 Unit)
The specification, estimation, and testing of dynamic models involving economic time series present a host of unique statistical problems requiring the use of specialized inference procedures. This course provides an overview of the most important of them. The focus will be on results most relevant for applications, with the various econometric techniques illustrated through problems in both macroeconomics and finance.

FINC 585-1 Asset Pricing I (1 Unit)
A doctoral-level course that offers an in-depth introduction to competitive asset pricing theory: arbitrage pricing, equilibrium pricing and optimal consumption/portfolio choice. Models are developed for a finite information tree, but from an advanced perspective that motivates and builds intuition toward continuous-time modeling.

FINC 585-2 Asset Pricing II (1 Unit)
This course covers recent developments in asset pricing theory, placing emphasis on the link between financial markets and the real
economy. The topics covered include: models of portfolio choice, general equilibrium models of risk and return, and models with financial frictions.

FINC 585-3 Asset Pricing III (1 Unit)
This course covers topics in the empirical asset pricing literature with an emphasis on recent developments. Topics include: Latent factor models; GMM theory and applications in finance; return predictability; performance evaluation; affine asset pricing models; Estimation of asset risk premia; estimation of volatility and jump risks from low/ high frequency data; empirical derivatives pricing using parametric and nonparametric methods.

FINC 586-1 Corporate Finance I (1 Unit)
This course introduces students to theories of corporate financing and investment decisions; optimal financial contracting and security design; financial intermediation; and financial crises. Throughout we study the effects of incentive problems and asymmetric information.

FINC 586-2 Corporate Finance II (1 Unit)
This course provides a theoretical and empirical treatment of major topics in empirical corporate finance, including: investment decisions, capital structure, corporate governance, and law and finance.

FINC 586-3 Corporate Finance III (1 Unit)
This course provides a theoretical and empirical treatment of major topics in empirical corporate finance, including financial contracting; banking, securitization, and financial regulation; household finance and macroeconomics; entrepreneurship and venture capital.

FINC 590-0 Research (3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

French (FRENCH)

FRENCH 401-0 Print Culture: Authors (1 Unit)
Content varies. Studies of one or several major literary or cultural figures of French and Francophone studies. Emphasizes their status within literary history or the cultural context of their work.

FRENCH 403-0 Foreign Language Teaching: Theory and Practice (1 Unit)

FRENCH 410-0 Studies in Medieval Literature (1 Unit)
Content varies. Samples: Romances by Chretien de Troyes, Christine de Pizan, and Marie de France.

FRENCH 420-0 Studies in the 16Th Century (1 Unit)
Content varies. Samples: Renaissance poetry; Rabelais; Montaigne.

FRENCH 421-0 Visual Culture:Cinema, Performance Studies & Multimedia (1 Unit)
Content varies. Contemporary French cinema and film history, television and multimedia cultures, courses on film directors.

FRENCH 422-0 Visual Culture: Art History & Literature (1 Unit)
Content varies: painting and literature, the circulation of works of art, the history of the relationship between literature and the visual arts.

FRENCH 430-0 Studies in the 17Th Century (1 Unit)
Content varies. Samples: the moralists; power and knowledge in classical theatre; the critique of rationality.

FRENCH 432-0 French, Francophone & Transnational Studies (1 Unit)
Studies of migration and diasporic discourses from missionary discourses and pre-modern travelers to contemporary globalized movements.

FRENCH 440-0 Studies in the 18th Century (1 Unit)
Content varies. Samples: The rise of the public sphere; Diderot's aesthetics; Rousseau and the French Revolution; the global eighteenth century.

FRENCH 441-0 Interdisciplinary, Theoretical and Critical Approaches (1 Unit)
An examination of theoretical discourses from disciplines other than literature (linguistics, philosophy, psychoanalysis, historiography) and their relationship to the French and Francophone world; history of ideas.

FRENCH 450-1 Studies in the 19Th Century (1 Unit)
Content varies. Samples: Literature and/of the city; literature and revolution.

FRENCH 460-0 Studies in 20Th Century Literature (1 Unit)
Content varies. Samples: Literature and cultural authority in 20th century France; l'amour, l'amour, le corps de l'écriture.

FRENCH 465-0 Topics in Francophone Colonial and Postcolonial Studies (1 Unit)
Content varies. Literature and culture of one or several geopolitical areas such as the Caribbean, the Maghreb, Sub-Saharan Africa or Vietnam.

FRENCH 470-0 Topics in Literary Studies (1 Unit)
Content varies. Studies of a motif, theme, genre or theoretical issue across languages.

FRENCH 490-0 Special Topics in Literature (1 Unit)
Content varies. Samples: literature of the African diaspora; women's autobiography.

FRENCH 492-0 Topics in Culture and Society (1 Unit)
Content varies. Samples: culture and politics of the 1920s and 1930s; early modern print culture, the Situationist International.

FRENCH 493-0 Topics in Literary Theory (1 Unit)
Topics in Literary Theory. Content varies (e.g., Post-structuralist Theory, Feminist Theory, Post-colonial Theory, Materialist/ Marxist Theory, Media Theory).

FRENCH 494-0 Interdisciplinary, Theoretical, and Critical Approaches (1 Unit)
Content varies. An examination of theoretical discourses from disciplines other than literature (linguistics, philosophy, psychoanalysis, historiography) and their relationship to the French and Francophone world; history of ideas.

FRENCH 495-0 Practicum in Scholarly Writing, Publication, & Research (1 Unit)
Required of all second year students. Under faculty supervision, students revise and expand a paper written in the first or second year of course work for submission for the second year review.

FRENCH 498-0 Independent Reading (1 Unit)
FRENCH 499-0 Independent Study (1 Unit)
May be repeated for credit. Permission of instructor and department required. Please contact department for permission number.

FRENCH 590-0 Research (1-3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit. Please see department for permission number.

FRENCH 596-0 PhD Thesis Tutorial (1 Unit)
Gender Studies (GNDR_ST)

**GNDR_ST 324-0 US Gay and Lesbian History (1 Unit)**
Gender, sexuality, and the rise of modern lesbian and gay identities. Lecture and discussion. HISTORY 324-0 and GNDR_ST 324-0 are taught together; may not receive credit for both courses.

**GNDR_ST 372-0 Gender, Sexuality, and Performance (1 Unit)**
Selected topics concerning theories of performance in relation to gender and/or sexuality. Content varies by quarter; may be repeated for credit with different topics.

**GNDR_ST 380-0 Black Feminist Theory (1 Unit)**
Survey of black feminist theories. Content may vary by quarter. Fulfills the major's theory requirement.

**GNDR_ST 390-0 Topics in Gender and Sexuality Studies (1 Unit)**
Topics vary. For example: masculinity, gender, race, and reproduction; gender, law, and public policy; Asian American women's history; women artists and their publics. May be repeated for credit with different topics.

**GNDR_ST 396-0 Senior Capstone Seminar (1 Unit)**
Introduction to research methods in the interdisciplinary study of gender and sexuality.

**GNDR_ST 397-0 Feminist Theory (1 Unit)**
Survey of gender and feminist theory. Content may vary by quarter. Fulfills the major's theory requirement.

**GNDR_ST 401-0 Graduate Colloquium (0.5-1 Unit)**
Graduate colloquium dedicated to the discussion of recent published work in gender and sexuality studies and of graduate student work in progress. This two-course colloquium will meet five times per quarter, for two quarters. Students will receive credit at the end of the school year.

**GNDR_ST 405-0 Advanced Feminist Theory (1 Unit)**
Survey of foundational feminist texts, and an exploration of the relationship between feminist theory and feminist practice, both within the academy and in the realm of politics.

**GNDR_ST 490-0 Topics in Gender and Sexuality Studies (1 Unit)**
Topics vary. May be repeated for credit with different topics.

**GNDR_ST 499-0 Independent Study (1 Unit)**
Individual tutorials or research projects. Prerequisite: consent of instructor.

**General Engineering (GEN_ENG)**

**GEN_ENG 519-0 Responsible Conduct for Research Training (0 Unit)**
The primary focus of this course will be on education in the responsible conduct of research (RCR), especially as it pertains to the engineering disciplines. Ethical and moral reasoning will be developed through analysis of case studies on the topics of conflict of interest, mentoring and lab management, collaborative research, data ownership and management, peer review, authorship, misconduct and the processes for handling misconduct.

**GEN_ENG 545-0 Teaching Experience (0 Unit)**
Participation in the teaching service of the department, commonly as a Teaching Assistant.

**GEN_ENG 546-0 Teaching Experience (0 Unit)**
Participation in the teaching service of the department, commonly as a Teaching Assistant.

**Genetic Counseling (GENET_CN)**

**GENET_CN 401-0 Introduction to Genetic Counseling (1 Unit)**
History of genetic counseling and clinical genetics, genetic counseling skills and process, eliciting patient histories, prenatal diagnosis counseling, introduction to diagnostic obstetric ultrasound, teratology, and high-risk obstetrics.

**GENET_CN 403-0 Professional Issues in Genetic Counseling (1 Unit)**
This course will examine legal, ethical, and other timely professional issues.

**GENET_CN 411-0 Psychosocial Aspects of Genetic Counseling I (1 Unit)**
An introductory course to human psychological development and counseling/interviewing skills as applied to genetic counseling.

**GENET_CN 412-0 Psychosocial Aspects of Genetic Counseling II (1 Unit)**
Builds on more theoretical coursework from earlier classes and examines normal and abnormal processes of pregnancy, prenatal diagnosis, birth of a child, and genetic disease for adolescents/adults.

**GENET_CN 413-0 Advanced Genetic Counseling (1 Unit)**
Second-year seminar focusing on advanced counseling principles and skills.

**GENET_CN 420-1 Principles of Medical Genetics I (1 Unit)**
Basic and complex principles of human heredity, including an introduction to cytogenetics, molecular technique and mathematical genetics.

**GENET_CN 420-2 Principles of Medical Genetics II (1 Unit)**
Approaches to clinical genetics, dysmorphology, and a variety of genetic diseases; application of medical and genetic information to genetic counseling of families.

**GENET_CN 420-3 Principles of Medical Genetics III (1 Unit)**
Biochemical genetics, immunology, pharmacogenetics, common adult genetic conditions and treatment of genetic disease.

**GENET_CN 421-0 Research Methods (1 Unit)**
Planning research projects, questionnaire development, research design, and approaches to clinical research.

**GENET_CN 422-0 Genetics Journal Club (0 Unit)**
Regular meetings to review current genetics journals and present articles of interest relevant to clinical genetics.

**GENET_CN 425-0 Adult Genetics (1 Unit)**
This class will consider the various adult onset complex disorders, ways to obtain and interpret family history for complex adult conditions, specific genetic risk assessment approaches, and ways to communicate risk to families.

**GENET_CN 499-0 Research Project (1 Unit)**
Development and presentation of a research project or case report in consultation with an advisory committee. Students will present a seminar on the project and prepare a paper that is expected to be submitted for publication and for presentation at a professional meeting.

**GENET-CN 525-0 Clinical Rotations (1 Unit)**
Rotations through the Genetic Counseling Clinic at local hospitals during the winter and spring quarters of the first year and the fall quarter of the second year.

**GENET-CN 530-0 Summer Clinical Rotation (3 Units)**
Two six-week, full-time summer rotations at clinical genetics centers in the Chicago metropolitan area.

**German (GERMAN)**

**GERMAN 324-0 Modern German Drama (1 Unit)**
Plays by authors ranging from Heinrich von Kleist to Peter Weiss, from the perspective of the stage as a "moral institution."
German (GERMAN)

**GERMAN 401-0 German Literature and Critical Thought 1750-1832 (1 Unit)**

This course begins with the formative aesthetic discussions undertaken by Lessing and Mendelssohn, turns to Kant's program for critical self-reflection, and considers a wide range of responses, including those of Schiller, the early romantics, Kleist, Hölderlin, and Goethe.

**GERMAN 402-0 History of Literature and Critical Thought 1832-1900 (1 Unit)**

Thematic approach to key texts of 19th century German literature between Goethe and Gottfried Keller, tragedy and the Bildungsroman. Literary and philosophical texts are read side by side in order to interrogate traditional concepts of realism, mimesis, and interpretation.

**GERMAN 403-0 German Literature, Critical Thought and New Media 1900-1945 (1 Unit)**

Built around selected key texts on the aesthetic theories of modernism (e.g., by Nietzsche, Adorno, Bürger, and Kittler), this course explores the relationship of literature and the visual arts and scrutinizes the status of literature within aesthetic production in modernity. Particular attention to works by Rilke, Kafka, Brecht, Lasker-Schüler, Benn, Musil, and Mann.

**GERMAN 404-0 German Literature, Critical Thought, and New Media since 1945 (1 Unit)**

Overview of the most influential texts that reflect the mounting concern with media in German literary and critical theory since the Second World War. Emphasis on the effects of the rise of media studies and theory on the understanding and interpretation of literature.

**GERMAN 405-0 Basic Issues in Foreign Language Teaching (1 Unit)**

This course focuses on basic principles of second language acquisition and language teaching methodology. It introduces students to the major trends and theories in language teaching. The critical reflection of pedagogical practices is emphasized.

**GERMAN 407-0 Proseminar (1 Unit)**

**GERMAN 431-0 Contemporary German Literature (1 Unit)**

Readings from authors representative of literature in the former East and West Germany's. May be repeated for credit with change of topic.

**GERMAN 441-0 Studies in Communication and Culture (1 Unit)**

Content varies. Samples; feminist literature, media studies, the history of literary journals, and other specific topics representative of current research interests. May be repeated for credit with change of topic.

**GERMAN 490-0 Independent Reading (1 Unit)**

May be repeated for credit. Permission of instructor and department required.

**GERMAN 499-0 Independent Study (1 Unit)**

May be repeated for credit. SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

**GERMAN 500-0 Research (1-3 Units)**

Independent investigation of selected problems pertaining to dissertation. May be repeated for credit. SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Global Health (GBL_HLTH)

**GBL_HLTH 390-0 Special Topics in Global Health (1 Unit)**

Advanced work in areas of developing interest and special significance. Can be repeated for credit with a different topic. Offered on campus and on Northwestern programs abroad. Recent courses include Ecology of Infant Feeding, Native American Health, and Public Health and Mental Health in Serbia.

Greek (GREEK)

**GREEK 301-0 Readings in Greek Literature (1 Unit)**

Selected authors and topics. Topics recently offered include Homer, Plato, Aeschylus, Herodotus, Sophocles, and Thucydides. May be repeated for credit with different topics. Prerequisite: GREEK 201-3 or consent of instructor.

**GREEK 499-0 Independent Study (1 Unit)**

SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Health and Biomedical Informatics (HBMI)

**HBMI 421-0 American Healthcare System (1 Unit)**

The course provides knowledge of the key components of health care in the United States—the policy, economic, and societal forces that shape health care delivery. The course serves as an introduction to elements of the American health care system, including the provider components, the financing of health care, the basic structure of public policy making and public health systems, a comparative analysis of the American system to health care systems of other countries, and the legal and regulatory framework within the American health care system functions. In addition to the structural components of the system, the course reviews current issues within the American health care system, including public health, preparedness, quality of health care, health reform, payment mechanisms, and consumerism.

**HBMI 422-0 Introduction to Clinical Thinking (1 Unit)**

This course provides an introduction to the clinical environment throughout the health center. It is designed for students not previously involved in clinical medicine and those trained in medicine outside the United States. The course features problem-based learning and traditional medical informatics task domains and covers medical terminology and basic pathophysiology. Topics include the clinical setting, eliciting information from patients, synthesizing the history
and physical examination, establishing diagnosis, treatment planning, integrating evidence-based medicine, and using an intelligent medical record in a complex environment. This is a technologist-track course for students with little clinical experience.

**HBMI 423-0 Decision Support Systems and Health Care (1 Unit)**
This course provides an introduction to clinical decision support systems in health information technology. Instruction is given in formal decision analysis techniques as they apply to decisions in the medical domain. Clinical decision support systems are introduced and issues relating to their design and implementation discussed. The mathematical foundations upon which they are based will be examined. Evidence-based guidelines and performance measurement techniques will be presented. A framework for designing and implementing clinical decision support systems will be introduced. Principles learned from this framework will be applied in writing a final paper that describes a prototype decision support system, including justification for its use and a description of steps followed in its design, implementation and performance measurement.

**HBMI 499-0 Health and Biomedical Informatics (HBMI) Independent Study (1 Unit)**
Independent Study and Research.

**Health Sciences Integrated Program (HSIP)**

**HSIP 400-1 Interdisciplinary Health Sciences Doctoral Colloquium (0 Unit)**
Year-long introduction to foundational issues in Health Sciences Disciplines that comprise the PhD program.

**HSIP 400-2 Interdisciplinary Health Sciences Doctoral Colloquium (0 Unit)**
Year-long introduction to foundational issues in Health Sciences Disciplines that comprise the PhD program. Prerequisite: HSIP 400-1.

**HSIP 400-3 Interdisciplinary Health Sciences Doctoral Colloquium (1 Unit)**
Year-long introduction to foundational issues in Health Sciences Disciplines that comprise the PhD program. Prerequisite: HSIP 400-2.

**HSIP 401-0 Introduction to Health Measurement Science (1 Unit)**
This course will focus on methodological issues regarding the design, implementation, analysis, and interpretation of health measures.

**HSIP 430-0 Introduction to Social Sciences and Health (1 Unit)**
The objective of this course is to introduce students to the role of social sciences in health and how researchers study psychosocial and behavioral variables in the context of health. The central focus will be on research done within the Department of Medical Social Sciences (MSS).

**HSIP 440-0 Introduction to Medical Informatics (1 Unit)**
This course is a survey of fundamental concepts and activities on information technology as applied to health care.

**HSIP 441-0 Health and Biomedical Informatics Methods I (1 Unit)**
This is the first course in a three-course series that provides an extended introduction to the methodologies of biomedical informatics. Prerequisite: May be taken with instructor approval.

**HSIP 442-0 Biomedical Informatics Methods II (1 Unit)**
This course is the second in a series of courses offered to educate students about methodologies utilized in biomedical informatics. Prerequisite: HSIP 441-0; may be taken with instructor approval.

**HSIP 443-0 Biomedical Informatics Methods III (1 Unit)**
This course is the third in a series of courses offered to educate students about methodologies utilized in biomedical informatics. Prerequisite: HSIP 441-0 and HSIP 442-0; may be taken with instructor approval.

**HSIP 445-0 Data Science for Clinical, Translational, and Population Researchers (1 Unit)**
Due to advances in technology and data collection, the ability to analyze complex data sets is a necessary skill for all clinical, translational and population researchers. A variety of data analysis tools exist, some unique to specific domains. This course provides an introduction to the data, analysis tools, ethical considerations, and terminologies from across biomedical data science with an emphasis on clinical, translational and population methods and tools.

**HSIP 499-0 Independent Study (0.5-2 Units)**
Graded independent study course for students in the Health Sciences Integrated Program.

**HSR 401-0 Introduction to Quantitative Methods in Health Services & Outcomes Research (1 Unit)**
This course introduces descriptive and analytic epidemiology and how to apply these methods to the study of health services and outcomes research. Key epidemiological concepts such as association, bias and confounding will be covered, as well as the main epidemiologic study designs. Topics include overview of research design, basic measurement of health services data, defining and measuring appropriate health outcomes, constructing research questions, conducting univariate analyses, and interpreting results.

**HSR 425-0 Health Economics and Healthcare Financing (1 Unit)**
This course examines selected topics in health economics that have major implications for healthcare delivery, healthcare financing and clinical and public health research. Essential economic theories and methods for exploring each topic will be discussed along with examples drawn from the existing research literature on the application of these theories and methods.

**HSR 433-0 Applied Qualitative Methods and Analysis for Health Researchers (1 Unit)**
This course focuses on qualitative research methods and analytic approaches that are often used in health services research, including in-depth and semi-structured interviews, focus groups, and participant observation. This course prepares the researcher to choose appropriate applications of qualitative methods, to conduct a variety of qualitative studies, and to interpret the meaning of events from the participant’s point of view, using multiple methods.

**HSR 456-0 Ethical Issues in Health Services Research (0.5 Unit)**
This course provides an overview of ethical principles for the responsible conduct of research and ethical issues related to conducting health services research, such as electronic records research, working with large
data sets, vulnerable populations, and community-based participatory research.

HSR 461-0 Topics in Health Services Research: Methods & Measurement (0.5 Unit)
This course provides an overview of methods for conducting health services and outcomes research. It is intended to complement students’ training in epidemiology and biostatistics, and help prepare students to conduct independent research. Topics include: identifying appropriate conceptual models, conducting systematic literature reviews, basic survey design and implementation, approaches to using mixed methods, and navigating popular data sets.

HSR 462-0 Topics in Health Services Research: Grant Writing (0.5 Unit)
This course will provide students with an overview of the grant writing process and practical strategies for writing successful grant proposals. The course includes online lectures, faculty-led writing workshops, guest lectures and discussions, and a mock study section in which students critically evaluate grant proposals.

HSR 463-0 Topics in HSR: Healthcare Quality and Patient Safety (0.5 Unit)
The course will provide an overview of topics related to healthcare quality and patient safety that are commonly encountered in health services and outcomes research. The course consists of online assignments and discussions on various topics, including organizational culture, quality measurement, risk analysis, process improvement, and health information technology.

HSR 465-0 Intermediate Quantitative Methods in Health Services & Outcomes Research (1 Unit)
This course provides the student with an opportunity to learn and practice more advanced epidemiologic methods in the context of health services and outcomes research. Topics include: epidemiologic research strategies and how to apply these to various research questions, review of univariate analysis (e.g., odds ratios, chi-sq tests), issues in effect estimation (precision, selection bias, misclassification bias), methods for dealing with covariates (stratified analysis, effective modification, confounding), introduction to multivariate analysis, and interpreting research findings to guide decision-making. Includes practical computer-lab sessions in Stata.

HSR 470-0 Federal Policy Making and Health Care Reform (1 Unit)
This course has three major objectives: (1) to introduce students to the policy making process and the roles of various policy actors, (2) to improve students’ knowledge of current health policy issues, and (3) to prepare students to participate in the policy process.

HSR 480-0 Advanced Qualitative Methods & Analysis for Health Researchers (1 Unit)
Students engaged in a specific qualitative research project will receive tailored guidance on conceptualization, data collection, analysis, and report writing. Students should take HSR 456 and receive permission from the instructor prior to registering.

HSR 498-0 Independent Study (0.5 Unit)
With guidance from a faculty member, the student develops a course of study that advances his or her knowledge in a particular area related to health services or outcomes research. The Student must identify a faculty member who is willing to sponsor and oversee the independent study course.

HSR 499-0 Independent Study (1 Unit)
With guidance from a faculty member, the student develops a course of study that advances his or her knowledge in a particular area related to health services or outcomes research. The Student must identify a faculty member who is willing to sponsor and oversee the independent study course.

HSR 500-0 Capstone Project (1 Unit)
The Capstone Project serves as a culminating experience and summative product of students’ experiences in the Master’s program. By completing the Capstone Project, students will: (1) develop, conduct, and complete an original and independent health services and/or outcomes research study, and (2) report the results in a completed manuscript that is ready to submit for publication.

HSR 501-0 HSR Capstone II (0.5 Unit)
The Capstone Project serves as a culminating experience and summative product of students’ experiences in the Master’s program. By completing the Capstone Project, students will: (1) develop, conduct, and complete an original and independent health services and/or outcomes research study, and (2) report the results in a completed manuscript that is ready to submit for publication.

Healthcare Quality and Patient Safety (HQS)

HQS 401-0 Introduction to Healthcare Quality (1 Unit)
This course introduces students to the history, definitions, and measurement of healthcare quality. Students achieve familiarity with measurements of quality in healthcare in a variety of healthcare settings as well as with public policy drivers of quality improvement. Interactive exercises and discussions engage students in the challenges of behavior change, reliable quality measurement and quality improvement, and the role of public policy as a driver of improvement.

HQS 402-0 Introduction to Patient Safety (1 Unit)
This course introduces students to the epidemiology of patient safety and relevant theory, content, tools, and methods in the field of patient safety, including systems thinking. Patient safety problems and high-risk contexts for error occurrence are introduced. Through interactive exercises and discussion, students conduct risk assessments and learn the legal and regulatory requirements of healthcare organizational leadership. Students also consider the roles of varied healthcare stakeholders in building a safer healthcare system.

HQS 420-0 Introduction to US Health Care System (1 Unit)
Course Aims: Be able to state and explain the structure, key facts and important issues pertaining to the U.S. health system. Be able to research topics for further study by becoming familiar with the relevant literature and be able to analyze problems in this sector by understanding applicable frameworks.

HQS 430-0 Capstone Class I (1 Unit)
Students develop and implement, in a healthcare context, a focused improvement project in healthcare quality or safety. This course provides a group-mentored experiential learning opportunity to engage in the practice of healthcare quality and patient safety innovation and improvement. The Capstone Program encourages students to develop a project in areas needing substantial improvement, test their skills and leadership capacities, reach beyond their current professional roles, and imagine future leadership in quality and safety.

HQS 435-0 Capstone Class II (1 Unit)
This course is a continuation of HQS 430: Capstone Class I. In a group-mentored context, students continue the application of their Capstone Project and present on challenges they have encountered and how these challenges have been overcome. Students receive directed feedback to
increase the potential for success of the Capstone Project and to reach their leadership goals and capacity.

**HQS 440-0 Fundamental Methods for Healthcare Quality and Patient Safety (1 Unit)**
Students gain working knowledge of approaches to measuring healthcare quality improvement patient safety efforts. Topics include performance measurement and methods for statistical process control assessment, emphasizing application of these techniques in local and national quality improvement efforts. Students develop knowledge and practice skills to evaluate and use empirical knowledge in healthcare quality and safety and to critically evaluate literature-based evidence and other information disseminated with regard to national efforts.

**HQS 499-0 Independent Study (1 Unit)**
This course provides Healthcare Quality and Patient Safety students with an opportunity to explore an area of interest related to patient safety and quality improvement. The primary objective of the Independent Study is to facilitate the student's career advancement goals.

Prerequisites: HQS 401-0 and HQS 402-0.

**HQS 501-0 Advanced Healthcare Quality (1 Unit)**
Students achieve advanced familiarity and skills with definition and measurement of quality in a variety of health care settings, practice how to critique and improve measures, understand the evidence and techniques for effective improvement science, develop leadership capacity and analytic skills, and gain skills to construct a credible, coherent quality improvement plan for a healthcare organization.

**HQS 502-0 Advanced Patient Safety (1 Unit)**
Students achieve advanced familiarity with patient safety theory, content, and skills, including application of High Reliability Organizational principals, to develop mastery in the field. In groups, students develop and apply evidence-based safety practices to address important safety problems. Through this, students develop proficiency in applying patient safety practices, methods, and Implementation Science frameworks; develop skills in safety redesign and improvement; and develop methods for patient safety education.

**HQS 510-0 The Business of Healthcare Quality and Safety Improvement (1 Unit)**
This course is taught by distinguished faculty from Northwestern's Kellogg School of Management and is designed to teach organizational and management theories through which students can apply their quality and safety knowledge and skills in the context of an organization. Topical content areas covered by this course include leadership, culture, negotiations, operations, organizational behavior, leading effective teams and change management.

### Hebrew (HEBREW)

**HEBR 410-0 Advanced Study (1 Unit)**

### Hindi and Urdu (HIND_URD)

**HIND_URD 410-0 Advanced Study (1 Unit)**

### History (HISTORY)

**HISTORY 300-0 New Lectures in History (1 Unit)**
Lecture courses on special topics not covered in regular offerings. Content varies. May be repeated for credit with different topic.

**HISTORY 305-0 American Immigration (1 Unit)**
Themes in history of immigration, especially from Europe, Latin America, and Asia. Law, racial formation, acculturation, transnational and international contexts, competing notions of citizenship. HISTORY 305-0 and LEGAL_ST 305-0 are taught together; may not receive credit for both courses.

**HISTORY 310-1 Early American History: Conquest and Colonization, to 1688 (1 Unit)**
Conquest and colonization.

**HISTORY 310-2 Early American History: The Age of the American Revolution, 1688-1789 (1 Unit)**
The age of the American Revolution.

**HISTORY 315-1 The United States Since 1900: Early 20th C. (1 Unit)**
America's domestic history and role in world affairs since 1900. Early 20th century.

**HISTORY 315-2 The United States Since 1900: Mid-20th C. (1 Unit)**
America's domestic history and role in world affairs since 1900. Mid-20th century.

**HISTORY 315-3 The United States Since 1900: Late 20th C. to Present (1 Unit)**
America's domestic history and role in world affairs since 1900. Late 20th century to the present.

**HISTORY 317-1 American Cultural History: 19th C. (1 Unit)**
Changing values of the American people, how they have been transmitted, and how they have shaped American society, politics, and the economy. 19th century.

**HISTORY 317-2 American Cultural History: 20th C. to Present (1 Unit)**
Changing values of the American people, how they have been transmitted, and how they have shaped American society, politics, and the economy. 20th century to the present.

**HISTORY 318-1 Legal and Constitutional History of the United States: Colonial Period to 1850 (1 Unit)**
Colonial period-1850. Development of legal institutions, constitutionalism, law and social change, law and economic development. Taught with LEGAL_ST 318-1; may not receive credit for both courses.

**HISTORY 318-2 Legal and Constitutional History of the United States: 1850 to Present (1 Unit)**
1850-present. Law in industrial society: administration, race relations, corporations, environmental protection, civil liberties. Taught with LEGAL_ST 318-2; may not receive credit for both courses.

**HISTORY 322-1 Development of the Modern American City: to 1880 (1 Unit)**
City characteristics of urban society in America from the period of settlement to the present. To 1880.

**HISTORY 322-2 Development of the Modern American City: 1880-Present (1 Unit)**
City characteristics of urban society in America from the period of settlement to the present. 1880-present.

*Historical Studies Distro Area*

**HISTORY 324-0 US Gay and Lesbian History (1 Unit)**
Gender, sexuality, and the rise of modern lesbian and gay identities. Lecture and discussion. HISTORY 324-0 and GNDR_ST 324-0 are taught together; may not receive credit for both courses.

*Historical Studies Distro Area*

**HISTORY 325-0 History of American Technology (1 Unit)**
American history through its material culture; industrialization and its discontents; consumer culture and household technology; mass communication and democracy; technological utopia and the computer revolution.

*Historical Studies Distro Area*

**HISTORY 326-1 The Development of Medieval Europe: Early Middle Ages, 300-1000 (1 Unit)**
Early Middle Ages, 300-1000.

*Historical Studies Distro Area*

**HISTORY 326-2 The Development of Medieval Europe: High & Late Middle Ages, 1000-1450 (1 Unit)**
High and Late Middle Ages, 1000-1450.

*Historical Studies Distro Area*

**HISTORY 330-0 The Age of the Renaissance (1 Unit)**
Decline and revival of European civilization, 1350-1530. Cultural, political, economic, and social developments.

*Historical Studies Distro Area*

**HISTORY 331-0 The Age of the Reformation (1 Unit)**
Europe in the 16th century, especially origins, evolution, and effects of changes in religion.

*Historical Studies Distro Area*

**HISTORY 332-1 The Development of Medieval Europe: Early Middle Ages, 300-1000 (1 Unit)**
Early Middle Ages, 300-1000.

*Historical Studies Distro Area*

**HISTORY 332-2 The Development of Medieval Europe: High & Late Middle Ages, 1000-1450 (1 Unit)**
High and Late Middle Ages, 1000-1450.

*Historical Studies Distro Area*

**HISTORY 333-0 The Age of the Renaissance (1 Unit)**
Decline and revival of European civilization, 1350-1530. Cultural, political, economic, and social developments.

*Historical Studies Distro Area*

**HISTORY 334-0 The Age of the Reformation (1 Unit)**
Europe in the 16th century, especially origins, evolution, and effects of changes in religion.

*Historical Studies Distro Area*

**HISTORY 338-1 Europe in the 20th Century, 1900-1945 (1 Unit)**
Growth of mass politics, fascism, the home fronts, rise of the welfare state, loss of empire, economic resurgence and integration. 1900-45.

*Historical Studies Distro Area*

**HISTORY 338-2 Europe in the 20th Century, 1945-Present (1 Unit)**
Growth of mass politics, fascism, the home fronts, rise of the welfare state, loss of empire, economic resurgence and integration. 1945-present.

*Historical Studies Distro Area*

**HISTORY 342-1 History of Modern France: Ancien Régime and the French Revolution (1 Unit)**
The Ancien Régime and the French revolution.

*Historical Studies Distro Area*

**HISTORY 342-2 History of Modern France: 19th c. to present (1 Unit)**
19th century to the present.

*Historical Studies Distro Area*

**HISTORY 344-2 Germany Since 1945 (1 Unit)**
Debates about the development of the postwar German states from 1945 to the present. Social, political, economic, and everyday history within the context of East, West, and unified Germany. GERMAN 344-2 and HISTORY 344-2 are taught together; may not receive credit for both courses.

*Historical Studies Distro Area*

**HISTORY 349-0 History of the Holocaust (1 Unit)**
Origins and development of the massacre of European Jewry during World War II.

*Historical Studies Distro Area*

**HISTORY 356-1 History of South Africa, Early Times to 1879 (1 Unit)**
From the African iron age to the establishment of the multinational gold mining industry, emphasizing the rise of African states and the contest for land with white settlers.

*Historical Studies Distro Area*

**HISTORY 356-2 History of South Africa, 20th century (1 Unit)**
Emphasis on the 20th century, the rise of African nationalism, and the clash with the apartheid state.

*Historical Studies Distro Area*

**HISTORY 357-0 East Africa (1 Unit)**
Selected topics in East African history.

*Historical Studies Distro Area*

**HISTORY 361-0 Modern Latin America: Mexico and its Revolutions (1 Unit)**
Mexican history, from the modernizing regime of Díaz, through the revolutionary upheaval and the consolidation of a new regime, to contemporary problems.

*Historical Studies Distro Area*

**HISTORY 362-1 Modern British History, 1688 - 1815 (1 Unit)**
Social, political, and institutional history, 1688-1815.

*Historical Studies Distro Area*

**HISTORY 362-2 Modern British History, 1780-1900 (1 Unit)**
The Victorians: liberalism, empire, and morality, 1780-1900.

*Historical Studies Distro Area*

**HISTORY 362-3 Modern British History, 1900-present (1 Unit)**
Empire to Cool Britannia, 1900-present.

*Historical Studies Distro Area*

**HISTORY 366-0 Race and Nation in the Independence Era (1 Unit)**
The process of Latin American independence, from the colonial background to 19th century insurgency wars, economic development, and nation formation, with emphasis on race and “the Indian question” in liberal thought.

*Historical Studies Distro Area*

**HISTORY 368-1 Revolution in 20th Century Latin America: Mexico and its Revolutions (1 Unit)**
Mexican history, from the modernizing regime of Díaz, through the revolutionary upheaval and the consolidation of a new regime, to contemporary problems.

*Historical Studies Distro Area*

**HISTORY 368-2 Revolution in 20th Century Latin America: Marxist Revolutions (1 Unit)**
Comparative study of the origins and aftermaths of major Marxist revolutions in Cuba and South and Central America.

*Historical Studies Distro Area*

**HISTORY 381-1 History of Modern China: Late Imperial China, 1600-1911 (1 Unit)**
Late Imperial China, 1600-1911.

*Historical Studies Distro Area*

**HISTORY 381-2 History of Modern China: 1911-present (1 Unit)**
1911-present.

*Historical Studies Distro Area*

**HISTORY 384-1 History of Modern Japan: The Modern State, 1860-1943 (1 Unit)**
Japan: the modern state, 1860-1943.

*Historical Studies Distro Area*

**HISTORY 384-2 History of Modern Japan: War and postwar Japan, 1943-present (1 Unit)**
War and postwar Japan, 1943-present.

*Historical Studies Distro Area*

**HISTORY 385-1 History of Modern South Asia, 1500-1800 (1 Unit)**
The early modern period, ca. 1500-1800: The Mughal Empire; the early phase of European trade and conquest in the subcontinent.

*Historical Studies Distro Area*

**HISTORY 385-2 History of Modern South Asia, ca. 1750-present (1 Unit)**
ca. 1750-present: The age of British colonial dominance; the politics of nation building and anticolonial resistance; independence, partition, and the postcolonial predicament.

_Historical Studies Distro Area_

**HISTORY 392-0 Topics In History (1 Unit)**
Advanced work through reading, research, and discussion in an area of special significance. Graduate students permitted in some courses with consent of instructor.

_Historical Studies Distro Area_

**HISTORY 405-0 Seminar in Historical Analysis (1 Unit)**
Seminars focused on historical methodology. Precise topics vary, generally multi-regional/multi-period.

**HISTORY 410-1 General Field Seminar in American History (1 Unit)**
Field seminar designed to familiarize students with pivotal issues, interpretations, controversies, research techniques, and works in the field relating to the history and historiography of early America, from the early colonial period through the early United States.

**HISTORY 410-2 General Field Seminar in American History (1 Unit)**
Field seminar designed to familiarize students with pivotal issues, interpretations, controversies, research techniques, and works in the field relating to the history and historiography of the nineteenth-century United States.

**HISTORY 410-3 General Field Seminar in American History (1 Unit)**
Field seminar designed to familiarize students with pivotal issues, interpretations, controversies, research techniques, and works in the field relating to the history and historiography of twentieth- and twenty-first century United States.

**HISTORY 430-1 Field Seminar in Medieval European History (1 Unit)**
An introduction to key primary and secondary sources in the High and Later Middle Ages that highlights methodology and critical debates.

**HISTORY 430-2 Field Seminar in Early Modern European History (1 Unit)**
Graduate student field seminar in early modern European history.

**HISTORY 430-3 Field Seminar in Modern European History (1 Unit)**
Graduate student field seminar in modern European history.

**HISTORY 443-1 Literature of Early Modern English Hist (1 Unit)**
Early modern Britain, 1500-1800, including society, religion, culture, and politics.

**HISTORY 443-2 Literature of Early Modern English Hist (1 Unit)**
The British Empire from its origins to 1800, including trade, exploration, ideology, and governance.

**HISTORY 446-0 Literature of English History of the 19th and 20th Centuries Britain (1 Unit)**
An introduction to some of the major debates and preoccupations of 19th and 20th c. British history.

**HISTORY 450-1 General Field Seminar in African History (1 Unit)**
First Africa field seminar of the year. Introduces students to the core literature in some subset of African history. Topics will vary.

**HISTORY 450-2 General Field Seminar in African History (1 Unit)**
Second Africa field seminar of the year. Introduces students to the core literature in some subset of African history. Topics will vary.

**HISTORY 465-0 Sources in African History (1 Unit)**
Explores the kinds of meanings that historians can recover from non-written sources and the ways in which recent scholarship has grappled with these sources.

**HISTORY 481-0 Western Literature of Chinese History (1 Unit)**
A sequence of courses that train students in the Western-language scholarship on China in the Qing, Republic, and PRC periods.

**HISTORY 483-0 Literature of Japanese History (1 Unit)**
Trains students in the major scholarship on various periods in Japanese history stretching from the seventeenth- to the twentieth-centuries.

**HISTORY 484-0 Literature of the History of Science (1 Unit)**
A graduate field seminar covering scholarly approaches to the history of science, technology, and medicine.

**HISTORY 490-0 Independent Reading (1-3 Units)**
Supervised readings on a particular historical topic with some mechaism for assessing student mastery of the material.

**HISTORY 491-0 TA Assistantship (1 Unit)**
Administrative registration for graduate students who are TAing an undergraduate class.

**HISTORY 492-0 Topics in History (1 Unit)**
New courses on cutting-edge topics. Topics will vary by instructor and year.

**HISTORY 499-0 Independent Study (1 Unit)**
May be repeated for credit. Permission of instructor and department required.

**HISTORY 550-0 Teaching History (0 Unit)**
Introduction to the main issues that students will confront as history teachers. Engagement with the most profound and interesting questions that arise in teaching history.

**HISTORY 570-1 Research Seminar in History (1 Unit)**
First half of the first-year research seminar. Students work jointly with the 570 instructor and their adviser to produce a polished research paper based on primary sources.

**HISTORY 570-2 Research Seminar in History (1 Unit)**
Second half of the first-year research seminar.

**HISTORY 580-1 Directed Research in History (1 Unit)**
First half of the second-year directed research course. Students work with their advisers to produce a paper which may be research-based or historiography-based, depending on individual needs.

**HISTORY 580-2 Directed Research in History (1 Unit)**
Second half of the second-year directed research course.

**HISTORY 585-0 Divisional Seminar in American History (0 Unit)**
The dissertation workshop is an ongoing forum for advanced students in U.S. history at which they present and get feedback on dissertations in progress (prospectuses, chapters, etc.) and other scholarly writings participants may wish to present.

**HISTORY 590-0 Research (1-3 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

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**Human Development & Social Policy (HDSP)**

**HDSP 401-0 Proseminar in Human Development and Social Policy I (1 Unit)**
Conceptual framework for studying human development, socialization, and social policy. Theoretical and empirical studies.

**HDSP 402-0 Child Development and Social Policy (1 Unit)**
Major theories and current empirical research concerning cognitive and social/emotional development of children. Interaction of internal maturational factors with effects of families, peers, and schools.
HDSP 403-0 Adolescent Development (1 Unit)
Biological, cognitive, and social development during adolescence. Social institutions and policies that affect the well-being of adolescents.

HDSP 404-0 Adult Development and Aging (1 Unit)
Concepts, theories, and research on development and adaptation from early adulthood through aging: age periods, transitions; cognitive, moral, and faith development; psychosocial and ego development; defense mechanisms; death and dying.

HDSP 410-0 Quantitative Methods I: Probability and Statistics (1 Unit)
HDSP 411-0 Quantitative Methods II: Regression Analysis (1 Unit)
HDSP 412-0 Quantitative Methods III: Empirical Tools for Causal Quantitative Analysis (1 Unit)
HDSP 413-0 Theories of Human Development (1 Unit)
Biological bases and interactions with the social and physical environments as sources of human development. Social, emotional, and cognitive aspects of development. Theorists include Bowlby, Erikson, Piaget, Vygotsky, Mead, and Gardner.

HDSP 415-0 Nature vs. Nurture Revisited (1 Unit)
HDSP 421-0 Adult Development and Work Careers (1 Unit)
HDSP 427-0 Sociology of Education (1 Unit)
Conflicts between offering opportunity to youth and societal imperatives for selecting and preparing youth for future careers; how society and schools deal with this conflict. Approaches to policy reform.

HDSP 428-0 Education Policy: Design, Implementation and Effects (1 Unit)
HDSP 429-0 Social-Community Interventions (1 Unit)
Design and implementation of social systems interventions in organizations and communities, especially preventive applications in human service agencies and institutions.

HDSP 430-0 Economics of Social Policy (1 Unit)
Economic context for social policy (economic crisis, unemployment, poverty); household economics; labor market theory and studies; economic rationales for social policy.

HDSP 432-0 Field Methods (1 Unit)
The contribution of ethnography to the study of social policy. Strengths and weaknesses of this method for study of governmental programs' impact on clients and participants.

HDSP 433-0 Modern Theories of the State and Social Policy (1 Unit)
Recent theories of social policy in the context of the welfare state. Analysis of alternative theories and their implications for contemporary problems in social policy.

HDSP 435-0 Advanced Qualitative Methods (1 Unit)
HDSP 440-0 The Politics of Public Policy (1 Unit)
Framework for understanding the structure and process of development. How existing social policies can be analyzed and new policies developed.

HDSP 442-0 Social Policymaking and Policy Implementation (1 Unit)
HDSP 451-0 Topics in Human Development & Soc Policy (1 Unit)
Topics may vary. May be repeated for credit with change of topic.

HDSP 481-0 Practicum in Human Development & Soc Pol (1-3 Units)
Specialized fieldwork opportunities. May be repeated for credit.

HDSP 491-0 Readings in Human Development & Soc Pol (1 Unit)
Specialized study between student and faculty sponsor. May be repeated for credit with change of topic.

HDSP 499-0 Independent Study in Human Dev & Soc Pol (1 Unit)

Humanities (HUM)
HUM 395-0 Humanities Seminar (1 Unit)
Interdisciplinary course offered by a changing roster of humanities faculty. Topics have included cities as modern utopia/dystopia in Europe, Asia, and America; the afterlife of Marxism; the politics of reputation; being animal, being human.

Industrial Engineering & Management Sciences (IEMS)

IEMS 303-0 Statistics (1 Unit)
Introduction to the foundations of statistics and statistical computing for data analysis and their applications. Descriptive statistics and statistical inference for estimation, testing, and prediction. May not receive credit for both IEMS 303-0 and any of IEMS 201-0, STAT 210-0, BMD_ENG 220-0, or CHEM_ENG 312-0. May not be taken for credit with or after STAT 320-1.
Prerequisites: IEMS 202-0 or equivalent; COMP_SCI 110-0 or COMP_SCI 111-0 or equivalent.

IEMS 304-0 Statistical Learning for Data Analysis (1 Unit)
Predictive modeling of data using modern regression and classification methods. Multiple linear regression; logistic regression; pitfalls and diagnostics; nonparametric and nonlinear regression and classification such as trees, nearest neighbors, neural networks, and ensemble methods.
Prerequisites: IEMS 303-0 and COMP_SCI 111-0 or equivalents.

IEMS 307-0 Quality Improvement by Experimental Design (1 Unit)
Methods for designing and analyzing industrial experiments. Blocking; randomization; multiple regression; factorial and fractional factorial experiments; response surface methodology; Taguchi's robust design; split plot experimentation. Homework, labs, and project.
Prerequisite: IEMS 201-0, IEMS 303-0, or equivalent.

IEMS 308-0 Data Science and Analytics (1 Unit)
Focuses on select problems in data science, in particular clustering, association rules, web analytics, text mining, and dimensionality reduction. Lectures will be completed with exercises and projects in open source framework R. Prior knowledge of classification techniques and R is required.
Prerequisites: IEMS 304-0; COMP_SCI 217-0.

IEMS 310-0 Operations Research (1 Unit)
Survey of operations research techniques. Linear programming, decision theory, stochastic processes, game theory. May not be taken for credit with or after IEMS 313-0.
Prerequisites: IEMS 201-0 or IEMS 202-0; GEN_ENG 205-1 or MATH 240-0.

IEMS 313-0 Foundations of Optimization (1 Unit)
Formulation and solution of applicable optimization models, including linear, integer, nonlinear, and network problems. Efficient algorithmic methods and use of computer modeling languages and systems. Homework, exams, and project.
Prerequisites: COMP_SCI 111-0; GEN_ENG 205-1; MATH 228-1; sophomore standing.

IEMS 315-0 Stochastic Models (1 Unit)
Fundamental concepts of probability theory; modeling and analysis of systems having random dynamics, particularly queueing systems. Prerequisites: IEMS 202-0 and concurrent enrollment in IEMS 303-0; GEN_ENG 205-1.

IEMS 317-0 Discrete Event Systems Simulation (1 Unit)
Computer simulation of discrete-change systems subject to uncertainty. Choice of input distributions; development of models; design and analysis of simulation experiments. Mini-projects, exams, and computer labs. Prerequisites: IEMS 303-0; IEMS 310-0 or IEMS 315-0.

IEMS 325-0 Engineering Entrepreneurship (1 Unit)
Overview of the entrepreneurial process from an engineering perspective. Idea generation, planning, financing, marketing, protecting, staffing, leading, growing, and harvesting. Students write startup business plans. Lectures, guest speakers, and case studies. Taught with ENTREP 325-0; may not receive credit for both courses. Prerequisite: 1 course in accounting or finance such as CIV_ENV 205-0 or ENTREP 330-1.

IEMS 341-0 Social Networks Analysis (1 Unit)
The use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales, ranging from small groups to the World Wide Web. How we create social, economic, and technological networks, and how they enable and constrain attitudes and behaviors.

IEMS 342-0 Organizational Behavior (1 Unit)
Manager’s view of tools available to recruit, develop, appraise, compensate, organize, and lead a team going through change. Application of psychological principles relating to human dynamics, motivation, teams, power, and organizational culture. Lectures, guest speakers, and exams. Work experience recommended.

IEMS 343-0 Project Management for Engineers (1 Unit)
A case study-based exploration of the body of project management knowledge. Key topics include project scheduling, risk management, project leadership, small-group dynamics, project methodologies, lifecycle concepts, and project controls. A Socratic approach is taken to exploring various case studies in the context of established and leading-edge project management concepts. Prerequisites: CIV_ENV 205-0 and IEMS 303-0.

IEMS 344-0 Leading Organizations and Teams (1 Unit)
In this class, a combination of theory and practice are leveraged to help students develop their leadership skill-set so that they can become more effective leaders of teams and organizations. In particular, fundamental tools and concepts from the behavioral and social sciences are studied that will help students’ to analyze organizational dynamics and to take robust action. In addition, students explore their own “leadership brand” and begin to answer the question of what type of leader they aspire to become so that they can thoughtfully and deliberately manage their careers. Prerequisite: Junior standing.

IEMS 345-0 Negotiations and Conflict Resolution for Engineers (1 Unit)
In this highly interactive class, students participate in negotiation and dispute resolution simulations that range in complexity from single-party/single-issue to multiparty/multi-issue cases. In addition students explore the role of agents and third parties in the managing conflict. Throughout all of the simulations integrative and distributive strategies are emphasized that can be applied across a variety of contexts. Prerequisite: Junior standing.

IEMS 351-0 Optimization Methods in Data Science (1 Unit)
Introduction to nonlinear mathematical optimization with applications in data science. The theoretical foundation and the fundamental algorithms for nonlinear optimization are studied and applied to supervised learning models, including nonlinear regression, logistic regression, and deep neural networks. Students write their own implementation of the algorithms in the Python programming language and explore their performance on realistic data sets. Prerequisites: COMP_SCI 111-0 and IEMS 303-0 and IEMS 313-0, or equivalent.

IEMS 373-0 Intro to Financial Engineering (1 Unit)
Financial markets, derivative securities, risk management, mathematical models in finance. Foreign exchange, debt, equity, commodity markets. Investing, trading, hedging, arbitrage. Forwards, futures, options, swaps, exotic derivatives. Models of price dynamics, binomial model, introduction to Black-Scholes theory and Monte Carlo simulation. Homework, projects, and guest speakers. Prerequisites: CIV_ENV 205-0, IEMS 315-0, MATH 228-2, and COMP_SCI 111-0, or equivalent or consent of instructor.

IEMS 381-0 Supply Chain Modeling and Analysis (1 Unit)
Application and development of mathematical modeling tools for the analysis of strategic, tactical, and operational supply-chain problems, including facility location, customer assignment, vehicle routing, and inventory management. Related topics including the role of information and decision support systems in supply chains. Homework, exams, and project. Prerequisite: IEMS 313-0.

IEMS 382-0 Production Planning and Scheduling (1 Unit)
Applications of operations research methods to practical problems of production planning and inventory control. Forecasting; aggregate planning; deterministic and stochastic inventory models; MRP; JIT; variability; scheduling in production and service systems. Case studies, homework, and exams. Prerequisites: IEMS 202-0; IEMS 310-0 or IEMS 315-0.

IEMS 383-0 Service Operations Management (1 Unit)
Exploration of service industries: cost-reduction and service-enhancement models, location planning, workforce scheduling, yield management, queuing analysis, and call-center management. Prerequisites: IEMS 313-0, IEMS 315-0.

IEMS 385-0 Introduction to Health Systems Management (1 Unit)
Health systems, lean concepts, patient-flow analysis, inference, and data-driven knowledge generation, decisions, and change. Forecasting, operations, and optimization of health resources. Prerequisites: IEMS 303-0, IEMS 313-0.

IEMS 395-0 Special Topics in Industrial Engineering (1 Unit)
Topics suggested by students or faculty members and approved by the department.

IEMS 401-0 Applied Mathematical Statistics (1 Unit)
An applied perspective on mathematical statistics. Topics include estimation, statistical decision theory, sufficiency and likelihood principle, unbiased estimation, convergence concepts, maximum likelihood estimation, Bayesian estimation, confidence intervals, hypothesis tests, non-parametric estimation and confidence intervals. Prerequisite: IEMS 303-0 or equivalent.

IEMS 411-0 Field Research in Organizations (1 Unit)
Methods for testing and evaluating proposed improvements or changes in the management of technical projects or organizations. Topics
IEMS 434-0 Systems Methodology (1 Unit)
Introduction to the concept of a system and unstructured, multidisciplinary problems. Fundamental systems models and concepts, modeling, and selected decision-making approaches.

IEMS 435-0 Stochastic Simulation (1 Unit)
Introduction to stochastic discrete-event simulation for graduate students, covering simulation modeling and programming; probability foundations of stochastic simulation; proper design and analysis of the simulation experiment; and simulation for research.
Prerequisites: IEMS 202-0 and IEMS 303-0 or equivalent; previous programming experience in some language.

IEMS 441-0 Social Network Analysis (1 Unit)
This seminar is intended to overview theoretical, computational, and analytic issues associated with network perspectives on communicating and organizing. The course will review scholarship on the science of networks in communication, computer science, engineering, organizational science, and social sciences in order to take an in-depth look at theories, methods, and tools to examine the structure and dynamics of networks.

IEMS 443-0 Health Policy Modeling (1 Unit)
PhD level course on the application of mathematical, statistical, economic, and systems models to problems in health policy.

IEMS 444-1 Healthcare Management Science (1 Unit)
The course focuses on models and methods for health resource allocation and utilization, planning, operations, policies, logistics, and treatments. A particular focus will be on predictive modeling techniques, multi-objective and stochastic decision making. Contemporary topics will be included as appropriate.

IEMS 445-0 Decision and Risk Analysis (1 Unit)
Theory and practice of decision making under uncertainty. Decision trees, influence diagrams, the value of information; Bayesian approaches, including conjugate and predictive distributions; utility theory foundations, risk preference, multi-attribute utility.
Prerequisite: IEMS 202-0 or equivalent.

IEMS 450-1 Mathematical Optimization I (1 Unit)
Linear programming formulation, simplex algorithm, optimality conditions, duality, sensitivity analysis, robust optimization, network flow, discrete optimization, Lagrangian method.
Prerequisites: Linear algebra and calculus.

IEMS 450-2 Mathematical Optimization II (1 Unit)
Constrained and unconstrained nonlinear optimization: Optimality conditions; linesearch and trust-region methods; Newton and quasi-Newton methods; active-set methods; augmented Lagrangian, sequential quadratic programming and interior point methods; convergence theory for numerical algorithm.
Prerequisites: Linear algebra and calculus.

IEMS 451-0 Stochastic Optimization (1 Unit)
Optimization under uncertainty, including modeling and applications; exact optimization methods; deterministic approximation and bounding techniques; and Monte Carlo sampling-based approximations.
Prerequisites: IEMS 450-1 and IEMS 401-0.

IEMS 452-0 Combinatorial Optimization (1 Unit)
Efficient methods and min-max results for combinatorial optimization problems including minimum spanning trees, shortest paths, maximum flows, minimum cost flows, matching; polyhedral combinatorics; complexity theory.
Prerequisite: IEMS 450-1 or equivalent.

IEMS 453-0 Robust Optimization (1 Unit)
Optimization with uncertain variables or parameters to find solutions that are both optimal and immune to uncertainties. Covers computational tools and applications including supply chains, revenue management, energy, portfolio theory, options pricing, risk management, healthcare, statistics and engineering design.
Prerequisite: IEMS 450-1 or equivalent.

IEMS 454-0 Large Scale Optimization (1 Unit)
Algorithms for large-scale optimization. Ellipsoid method and complexity of linear programming; equivalence of separation and optimization; path-following interior point methods, including self-dual methods; decomposition algorithms, including column generation and row generation for linear, nonlinear, and integer programming; selected applications.
Prerequisite: IEMS 450-1.

IEMS 455-0 Machine Learning (1 Unit)
A survey of large-scale machine learning with emphasis on neural networks and kernel methods, including model formulation, large-scale applications and training (optimization). Case studies include text classification, image and speech recognition, and recommender systems. Construction of deep neural networks for large data sets.
Prerequisites: IEMS 202-0, IEMS 303-0 and IEMS 313-0 (or equivalent) and computer programming.

IEMS 457-0 Integer Programming (1 Unit)
Methods for NP-hard discrete optimization problems including general methods like branch and bound and cutting planes, as well as special purpose branch-and-cut methods and heuristics.
Prerequisite: IEMS 450-1 or equivalent.

IEMS 459-0 Convex Optimization (1 Unit)
The course develops expert knowledge in the theory and algorithms for convex optimization. Emphasis is on understanding fundamental properties of convex sets and functions, and on the role of duality. Covers practical algorithms.
Prerequisites: IEMS 202-0, IEMS 303-0 (or equivalent), and IEMS 450-1 or IEMS 450-2 (or equivalent).

IEMS 460-1 Stochastic Processes I (1 Unit)
Prerequisite: Permission of instructor.

IEMS 460-2 Stochastic Processes II (1 Unit)
Prerequisite: Permission of instructor.

IEMS 462-1 Predictive Analytics I (1 Unit)
Parametric regression and classification models for analyzing medium to large data sets.

IEMS 463-0 Statistical Analysis (1 Unit)
Principles of experimental design and their application to the analysis of standard designs including one-way layout, block designs, factorial/fractional factorial experiments, random/mixed effect models, nested/split-plot designs.

IEMS 464-0 Advanced Queueing Theory (1 Unit)
Queueing networks, the single-server queue, heavy-traffic approximations for the G/G/1 queue. Advanced level.
Prerequisite: IEMS 460-1 or equivalent.

IEMS 465-0 Simulation Experiment Design & Analysis (1 Unit)
Selected current topics in modern stochastic simulation research, including variance reduction, simulation optimization, model risk, and simulation analytics.
Prerequisites: IEMS 435-0, IEMS 401-0 and IEMS 460-1, or equivalent.

IEMS 468-0 Stochastic Control (1 Unit)
Optimal control of Markov chains, dynamic programming, finite horizon and discounted models, and applications in operations research.
Prerequisite: IEMS 460-1.

IEMS 469-0 Dynamic Programming (1 Unit)
Theoretical and computational aspects of solving stochastic sequential decision problems. Material supported by many real-world applications.

IEMS 473-1 Financial Engineering I (1 Unit)

IEMS 473-2 Financial Engineering II (1 Unit)
Prerequisite: IEMS 450-1; students should be familiar with some high-level programming language.

IEMS 481-0 Logistics (1 Unit)
This course will provide an introduction to modeling and solution methods for facility location, transportation and inventory management decisions. By the end of the quarter, you should learn to model and formulate a variety of logistics problems; to develop and assess solution methods for these problems; and to use these tools to analyze strategic, tactical, and operational supply-chain decisions.
Prerequisites: IEMS 450-1; students should be familiar with some high-level programming language.

IEMS 482-0 Operations (1 Unit)
First Quarter: Introduction to production/logistics including: multi-objective, stochastic and dynamic facility location problems, multi-echelon and multi-item inventory models and heuristic, approximate and exact vehicle routing algorithms. Second Quarter: Introduction to production/distribution facility design and control, capacity management, push and pull production systems: MRP, JIT, ConWIP; introduction to deterministic and stochastic production scheduling: job shop, flow shop.
Prerequisites: IEMS 450-1 and at least concurrent enrollment in IEMS 460-1.

IEMS 484-0 Inventory and Distribution Systems (1 Unit)
Multistage inventory and production models, multiproduct systems, distribution systems, and random yield models.
Prerequisites: IEMS 481-0 and IEMS 482-0.

IEMS 488-0 Economics and Decision Analysis (1 Unit)
Investment project evaluation: time value of money, treatment of risk, asset evaluation; decision trees, utility theory and risk attitude, multiobjectives. Public sector decision analysis, including cost/benefit analysis, and cost/effectiveness analysis.
Prerequisite: Calculus.

IEMS 490-0 Selected Topics in IE (1 Unit)

IEMS 499-0 Projects (1-3 Units)

IEMS 499-0 Selected Topics in IE (1 Unit)

IEMS 490-0 Selected Topics in IE (1 Unit)

IEMS 488-0 Economics and Decision Analysis (1 Unit)

IEMS 482-0 Operations (1 Unit)

IEMS 469-0 Dynamic Programming (1 Unit)

IEMS 473-1 Financial Engineering I (1 Unit)

IEMS 473-2 Financial Engineering II (1 Unit)

IEMS 481-0 Logistics (1 Unit)

IEMS 482-0 Operations (1 Unit)

IEMS 484-0 Inventory and Distribution Systems (1 Unit)

IEMS 488-0 Economics and Decision Analysis (1 Unit)

IEMS 490-0 Selected Topics in IE (1 Unit)

IEMS 499-0 Projects (1-3 Units)

Initiative for Sustainability & Energy at NU (ISEN)

ISEN 410-0 Topics in Contemporary Energy and Climate Change (1 Unit)

ISEN 430-0 NUvention: Energy (1 Unit)

ISEN 440-1 Introduction to the Light Hydrocarbon Economy (1 Unit)
A survey course on all aspects of light hydrocarbons as a bridge to a net-zero carbon economy.

ISEN 440-2 Introduction to the Light Hydrocarbon Economy (1 Unit)
A survey course on all aspects of light hydrocarbons as a bridge to a net-zero carbon economy.

ISEN 490-1 Modern Techniques in Heterogeneous Catalysis Research (1 Unit)
A laboratory course supplemented by lectures, discussions, and review of current literature. Designed to develop proficiency in modern methods of the study of heterogeneous catalysts, as well as associated skills in critical thinking and oral and written communication.

ISEN 490-2 Modern Techniques in Heterogeneous Catalysis Research (1 Unit)
A laboratory course supplemented by lectures, discussions, and review of current literature. Designed to develop proficiency in modern methods of the study of heterogeneous catalysts, as well as associated skills in critical thinking and oral and written communication.

ISEN 495-0 Special Topics in Energy and Sustainability (1 Unit)

Integrated Life Sciences (IGP)

IGP 401-0 Biochemistry I (1 Unit)
Structures and properties of proteins, nucleic acids, and polymers, complex and simple carbohydrates, and lipids; thermodynamic principles applied to biologic systems; molecules; structural correlates and functional expressions.

IGP 403-0 Advanced Immunology (1 Unit)
Topics in immunology. Discussion of current experimental papers.

IGP 405-0 Cell Biology (1 Unit)
Structure and function of cells and their organelles. Morphological, molecular, and physiological approaches to solving cell-biological problems.

IGP 410-0 Molecular Biology (1 Unit)
Topics in molecular biology and the mechanisms of gene and cellular regulation.
Prerequisites: Past or simultaneous enrollment in IGP 401-0 or equivalent.

IGP 420-0 Introduction to Pharmacology (1 Unit)
This lecture-based course begins with an introduction to the basic principles of pharmacology, namely pharmacodynamics (what the drug does to the body) and pharmacokinetics (what the body does to the drug). The subsequent topics apply these basic pharmacological principles to a discussion of the normal physiology, the
pathophysiological processes that produce disease, and the targeted pharmacological treatment of disease. This integrated physiological, pharmacological and clinical approach will be applied to the following global topics in sequence: Neuropharmacology (Peripheral and Central Nervous Systems), Antimicrobial and Anticancer Chemotherapy, Cardiovascular and Renal Physiology and Pharmacology, Endocrine and Immunopharmacology.

**IGP 422-0 Introduction to Translational Research (1 Unit)**
This course is intended to introduce basic life sciences and clinical research graduate students to the thought processes involved in human disease research and its translation into therapy by providing an overview of disease processes, how they are treated, how basic biological science is used to develop those treatments, and the role of various stakeholders in the translational research pipeline. At the end of this course the student should understand the medical rationale for studying basic pathomechanisms and how to utilize that rationale to design studies and grant proposals. In addition, the student will obtain background knowledge for further, disease- or organ-specific upper-level courses.

**IGP 425-0 Topics in Drug Discovery (1 Unit)**
Key precedents and contemporary topics in drug discovery research in academia and industry. Principles of drug design and action, pharmacogenetics, macromolecular target identification and characterization, bioassays and animal models of disease, study design and information management.

**IGP 430-0 Genetics (1 Unit)**
Genetics of prokaryotic and eukaryotic organisms; gene regulation and variation; chromosome structure and behavior; linkage and recombination; quantitative and population genetics; biochemical and developmental genetics; and manipulation of genes in organisms, including humans.

**IGP 433-0 Advanced Microbial Pathogenesis (1 Unit)**
Properties of microorganisms important in the pathogenesis genesis of infectious diseases. Emphasis on molecular aspects of virulence as they relate to host-parasite interactions.

**IGP 435-0 Signal transduction and human diseases (1 Unit)**
Integrated discussion of different superfamilies of signaling receptors and their effectors. Pathways discussed include G-protein linked, growth factors and cytokines, nuclear receptors and transcription factors.

**IGP 436-1 Drugs and the Brain (1 Unit)**
Graduate neuropharmacology course with a mix of didactic instruction (33%) and in-depth classroom discussion of primary research papers (66%). The course is not a survey course, but rather will cover selected topics in neuropharmacology with the goals of 1) informing the student of the latest neuropharmacology knowledge, 2) inculcating a rigorous approach to examination of the scientific literature, and 3) encouraging best practices in experimental design.

**IGP 440-0 Immunology (1 Unit)**
An integrated view of contemporary immunology: antigens, antibodies, humoral and cell-mediated immune responses, cellular interactions, and regulation of immune responses.

**IGP 442-0 Microbiology (1 Unit)**
Structure and function, taxonomy and replication of infectious agents. Host-parasite interactions and microbial diseases.
Prerequisites: IGP 405-0, IGP 410-0, and IGP 401-0 or equivalent.

**IGP 450-0 Tumor Cell Biology (1 Unit)**
Basic aspects of the neoplastic phenotype, including morphologic, biochemical, genetic, cytogenetic, and other features; regulation of cell proliferation and differentiation; basic concepts in molecular mechanisms of chemical, viral, and radiation carcinogenesis; solid tumor growth, progression, and metastasis; tumor immunology.

**IGP 456-0 Topics in Developmental Biology (1 Unit)**

**IGP 466-0 Structural Basis of Signal Transduction (1 Unit)**
The structural and thermodynamic basis by which protein-protein or protein-nucleic acid interactions mediate signal transduction. Signaling pathways used to explore how the structural biological mechanisms underlying these pathways can be experimentally determined and understood.

**IGP 475-0 Virology (1 Unit)**
Mechanisms of genome replication, control of gene expression, and protein functions are analyzed in RNA and DNA viruses.

**IGP 480-0 Molecular Mechanisms of Carcinogenesis (1 Unit)**
Current literature relating experimental approaches and recent discoveries in the fields of cell biology, virology, and molecular genetics to mechanisms of carcinogenesis. Advanced level.

**IGP 484-0 Quantitative Biology: Statistics and Data Analysis for Life Scientists (1 Unit)**
Parametric statistics (such as the familiar t test); nonparametric and simulation approaches (such as permutation tests) better suited to "real" data; and a conceptual survey of more sophisticated data-mining/machine-learning techniques.

**IGP 485-0 Data Science For Biomedical Researchers (1 Unit)**
Introduction to the data and analysis tools from several areas of study within the Biomedical Informatics research spectrum. Didactic instruction as an introduction to the topics followed by hands-on demonstrations and exercises to reveal practical use of relevant software tools.

**IGP 486-0 Advance Bioinformatics and Genome Informatics (1 Unit)**
The course will be oriented towards graduate students in HSIP, DGP and related programs. It will consist of lectures/seminars, each two hours in duration. The course will introduce various high-throughput technologies, such as microarray and Next Generation Sequence data, for measuring and analyzing gene expression, chromosomal deletions and amplifications, methylation patterns and genome architecture. Further, various algorithms and bioinformatics tools for analyzing the produced high-dimensional data will be discussed. The course begins with couple of introductory lectures in the biology part (Experimental/Technology part - 2 hours duration - no laboratory) followed by presentations on algorithms and data analysis (Bioinformatics part - 2 hours duration). Finally some recently published articles using these technologies will be discussed. The course will conclude with analyzing and conducting pathway analysis on the resultant cancer gene lists and integration of clinical data.

**IGP 493-0 MOLECULAR BASIS OF NATURAL HISTORY (0 Unit)**
The molecular basis of natural history course will examine important examples from Nature and use the approaches of biochemistry, molecular biology and genetics to categorize and analyze the natural products produced by bacteria, plants and animals and examine how they have impacted human history. Most 2 hour sessions will be devoted to a particular topic. After an introduction by faculty, course participants will
examine the subject further through the discussion of assigned papers from the literature or other texts. Some sessions will also be devoted solely to presentations of topics by the students. All students will submit and essay on a topic covered by the course or a related topic in natural history.

IGP 494-0 Colloquium on Integrity in Biomedical Research (0 Unit)
Required by National Institutes of Health (NIH) but does not count as one of the required IGP courses.

IGP 495-0 Science and Society (0 Unit)
Exploration of the foundations of modern science and discussion of how these ideas impact social issues in the biomedical sciences (creationism, abortion, euthanasia, eugenics, cryogenics, replacement therapies, animal rights).

IGP 496-1 Introduction to Life Science Research (0 Unit)
Provides first-year IGP students with tools to develop the knowledge base and skill set necessary for competent research.

IGP 496-2 Introduction to Life Science Research (0 Unit)
Provides first-year IGP students with tools to develop the knowledge base and skill set necessary for competent research.

IGP 496-3 Introduction to Life Science Research (1 Unit)
Provides first-year IGP students with tools to develop the knowledge base and skill set necessary for competent research.

IGP 499-0 Independent Study (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

IGP 590-0 Research (1-3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation.

### Interdepartmental Biological Sciences Program (IBIS)

**IBIS 401-0 Molecular Biophysics (1 Unit)**
Protein structure; nucleic acids structure; forces that determine macromolecular structure; transport and diffusion; macromolecular assemblies; molecular machines and single molecule studies; x-ray crystallography; electron microscopy and image reconstruction; nuclear magnetic resonance; spectroscopy.

**IBIS 402-0 Eukaryotic Molecular Biology (1 Unit)**
Chromosome and genomic organization, gene structure, transmission of genetic information, transcriptional regulation of gene expression; Principles of protein folding; cellular mechanisms of protein quality control; transmission of prions and prion-like aggregates and amyloid and protein conformational diseases; Scales of organization of the transcriptome and proteome from individual pathways to complex networks, and from cellular to organismal levels.

**IBIS 403-0 The Human Proteome: Defining Variation and Modifications of Protein Molecules (1 Unit)**
The focus of the class is on the Human Genome and mass spectrometry-based proteomics.

**IBIS 404-0 Principles and Methods in Systems Biology (1 Unit)**
Systems biologists use mathematical-based experimental analysis and modeling to study biological problems. Quantitative techniques and computational tools help investigators analyze heterogeneous complex data about molecular networks to uncover meaningful relationships about key components. These studies inspire a framework for understanding the activity of living states. Related principles about dynamic biological systems are the focus of the systems biology course.

**IBIS 406-0 Advanced Topics in Cell Biology (1 Unit)**
This course provides the opportunity to explore areas of eukaryotic cell biology through analysis of scientific literature and in-depth background research. Students investigate cellular components, mechanisms, and methods used in cell biology research. Students present topics orally to their colleagues and use primary data from scientific publications to design, propose, and defend cell biology research projects.

**IBIS 407-0 Genetics & Epigenetics (1 Unit)**
Exploration of the classic and contemporary scientific literature on genetic and epigenetic control of phenotype, genetic analysis, genetic interactions, genetic model systems and genetic experiments. The focus of the course will be on learning to think about genetic data and to design genetic experiments and screens to answer biological questions.

**IBIS 409-0 Biophysical Methods for Macromolecular Analysis (1 Unit)**
The course will explore the principles and practical applications of biophysical methods in contemporary research, with an emphasis on understanding macromolecular structure and function. A broad range of techniques including various forms of spectroscopy and microscopy will be covered. Students will learn practical aspects of design and conduct of experiments and review scientific literature demonstrating the value of these methods.

**IBIS 410-0 Quantitative Biology (1 Unit)**
Quantitative approach to molecular and cell biology, focused on developing an understanding of connections between biomolecule structure and dynamics, and behavior of cells. The course will also include review of topics from statistics of random variables and statistical data analysis relevant to biology and biophysics.

**IBIS 416-0 Practical Training in Chemical Biology Methods and Experimental Design (1 Unit)**
Experimental design, data analysis, mass spectrometry; proteomics, in vivo and molecular imaging, small molecule synthesis and purification; high-throughput screening, x-ray crystallography, analysis of bioelements.

**IBIS 421-0 Rigor & Reproducibility in Research (0 Unit)**
Experimental and data analysis will be discussed through analysis of case studies on the topics of rigorous statistical analysis, transparency in reporting, data and material verification and sharing.

**IBIS 423-0 Ethics in Biological Research (0 Unit)**
The focus of this course will be on education in the responsible conduct of research (RCR). Topics discussed include: conflict of interest, the use of animals and human subjects in research, mentoring and lab management, collaborative research, data ownership and management, peer review, authorship, misconduct and the processes for handling misconduct.

**IBIS 432-0 Statistics for Life Sciences (1 Unit)**
Statistics course with emphasis on the application of statistical methods and data analysis techniques to the life sciences. Topics include descriptive statistics, normal distribution, random variables, sampling distribution, confidence intervals, hypothesis tests, p-values and multiple correction, linear regression, model selection, diagnostics, logistic regression, contingency tables, resampling, clustering, dimension reduction, and genomics data analysis.

**IBIS 455-0 Special Topics (1 Unit)**
Offered regularly for small groups of graduate students. The teaching faculty and topics change each quarter.

**IBIS 462-0 Seminar in Biological Sciences (0 Unit)**

**IBIS 491-0 Development and Evolution of Body Plans (1 Unit)**
Molecular mechanisms underlying early embryonic development, including establishment of the body and organogenesis. Discussion of original literature.

IBIS 499-0 Independent Study (1 Unit)
IBIS 519-0 Responsible Conduct of Research Training (0 Unit)
This course is a review of concepts introduced in IBIS 423-0. Prerequisite: IBIS 423-0 or equivalent.
IBIS 590-0 Research (1-3 Units)

Interdisciplinary Seminar (KPHD)

KPHD 520-0 Workshop on Research Development (0.5 Unit)
PhD students present new research ideas to faculty and students. Students must situate their ideas in a relevant literature, outline the type of results/analysis that the student expects to carry out, and most importantly, the potential contributions. Emphasis will be placed on the evaluating the viability of research ideas as job market papers.

KPHD 530-0 Idea Incubator for Behavioral Science (1 Unit)
The course challenges students to enhance their ability to generate, nurture and critique research ideas and relies heavily on group interaction, peer review, student presentations, and faculty coaching. Students will pick and then strengthen a publishable idea, and present their work to peers and faculty. By the end of the quarter students will have two refined research ideas. The course welcomes students in all years and programs who have an interest and emphasis in behavioral science (e.g., economics, management, marketing, psychology, sociology, etc.).

KPHD 540-0 Computational Social Science: Methods and Applications (1 Unit)
This course is designed to prepare PhD students for computational social science (CSS) research. These skills include data acquisition, null model design and programming, and data mining for structured and unstructured data. Prerequisites: Students must be proficient in basic Python programming. Students may either take NICO 101-0 and NICO 102-0 or complete lessons on Datacamp (python for data science, data science toolbox, pandas, and importing data lessons).

Italian (ITALIAN)

ITALIAN 490-0 Topics in Italian Literature and Culture (1 Unit)
Content varies. Samples: Italy and the Invention of the Orient; Gramsci Beyond Gramsci: Mapping Cultures in Italy and Abroad; Italian Feminism.
ITALIAN 498-0 Independent Reading (1 Unit)
ITALIAN 499-0 Independent Study (1 Unit)
May be repeated for credit. Permission of instructor and department required.

Japanese (JAPANESE)

JAPANESE 310-0 Japanese IV: Special Topics in Reading Japanese Literature in Japanese (1 Unit)
Reading of original texts of Japanese literature, criticism, and nonfiction focused on particular themes. Translation skills are emphasized; discussion in English. Prerequisite: grade of at least C- in JAPANESE 211-3 or equivalent. Literature Fine Arts Distro Area
JAPANESE 410-0 Advanced Study (1 Unit)

Korean (KOREAN)

KOREAN 410-0 Advanced Study (1 Unit)

Latin (LATIN)

LATIN 400-0 Medieval Latin (1 Unit)
LATIN 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Latin American & Caribbean Studies (LATIN_AM)

LATIN_AM 401-0 The Letter in Latin America: Writing and Power (1 Unit)

Latina and Latino Studies (LATINO)

LATINO 395-0 Capstone Seminar in Latina & Latino Studies (1-3 Units)
Advanced course synthesizing the state of current research. Questions the boundaries of Latina/o studies. Contextualizes research and topics in relation to other ethnic studies, gender/queer studies, and diaspora studies. Primarily for majors and graduate students. Prerequisite: consent of the program director.

Learning Sciences (LRN_SCI)

LRN_SCI 401-0 Knowledge Representation for the Learning Sciences (1 Unit)
Theoretical and methodological techniques for knowledge representation, primarily as practiced by cognitive scientists. Application of these techniques to issues of learning that are of interest to researchers in the learning sciences.

LRN_SCI 402-0 Social Dimensions of Teaching & Learning (1 Unit)
Students’ relationships with one another and with teachers in school and nonschool settings. Implications for classroom instruction of social learning theory, student diversity, classroom climate, cooperative and competitive goal structures, and processes of attribution and achievement motivation.

LRN_SCI 403-0 Foundations of the Learning Science (1 Unit)
Cognitive and social science theories of how people learn to understand, reason, and solve problems. Implications for the design of classroom learning environments; learning in real scenarios for investigating central issues in cognitive science. Learning in mathematics, science, reading/writing, and informal reasoning.

LRN_SCI 410-0 Quantitative Methods I: Probability and Statistics (1 Unit)

LRN_SCI 411-0 Quantitative Methods II: Regression Analysis (1 Unit)

LRN_SCI 413-0 Tangible Interaction Design and Learning (1 Unit)
This course will explore the use of tangible interaction to create innovative learning experiences. It will review both theoretical and technological foundations of the field. Topics include creative expression, embodied interaction, cultural forms, and design frameworks.

LRN_SCI 415-0 Field Methods (1 Unit)
The purpose of this course is to introduce students to the world of qualitative research so that they will be able to read qualitative studies intelligently, and learn to design and conduct qualitatively oriented studies themselves. Beginning with an overview of the epistemological assumptions behind different kinds of research, the course will explore various types of qualitative research approaches and the kinds of topics
and queries they support. Students will read and critique examples of published research of various kinds. Next, students will investigate the various methods of collecting qualitative data. The class is designed so that students simultaneously read about and discuss qualitative research, and gather data themselves. Although the course touches on analysis, the main focus is on developing a qualitative research project and collecting data for it.

**LRN_SCI 416-0 Advanced Qualitative Methods (1 Unit)**

**LRN_SCI 425-0 Introduction to Design for the Learning Sciences (1 Unit)**
Building the skills and knowledge necessary to support the design of educational experiences. Exploration of general design principles and learning sciences theoretical perspectives through examination of existing cases of instructional design. A design project involving needs analysis, specifying learning objectives, and designing a new educational experience.

**LRN_SCI 426-0 Design of Technological Tools for Thinking and Learning (1 Unit)**

**LRN_SCI 429-0 Design of Learning Environments (1 Unit)**
Issues in designing and studying innovative learning environments. New models of classroom interaction, particularly using technology to enable new cognitive and social roles for students. Topics include simulations, tutors, computer-mediated communication, project-based learning. Theoretical motivations in cognitive and social-interaction learning theories, empirical studies evaluating their effectiveness, and prospects for propagation of such innovations.

**LRN_SCI 434-0 Teacher Thinking & Learning (1 Unit)**
Recent research on teacher cognition, how teacher knowledge is organized and accessed, and relationship between knowledge and practice. Investigate novice and veteran teachers learning.

**LRN_SCI 438-0 Teaching with Technology (1 Unit)**
Conceptual strategies for integrating technology into effective pedagogy and practical strategies for employing technology in classrooms. Includes hands-on experience with technology and a design project.

**LRN_SCI 442-0 Social Policymaking and Policy Implementation (1 Unit)**

**LRN_SCI 443-0 Educational Policy: Design, Implementation and Effects (1 Unit)**
Introduction to issues in educational reform. Analyzing educational reform; framing educational policy problems; examining reformers’ assumptions about the school system, about the roles of school in society, and about teaching and learning. The course is grounded in school decentralization, systemic reform and school choice.

**LRN_SCI 451-0 Topics in Learning Sciences (1 Unit)**
Discussion of trends in the field of Learning Sciences via articles and other resources.

**LRN_SCI 452-0 Constructionism Seminar (1 Unit)**
Discussion of trends in the field of Learning Sciences via articles and other resources.

**LRN_SCI 463-0 Topics in Research Methods (1 Unit)**
Methodological approaches to research on learning-teaching environment implementation. Methods for examining processes of change and adoption of educational interventions in various settings. May be repeated for credit with change of topic.

**LRN_SCI 477-0 Philosophical & Historical Foundations of Education Reform (1 Unit)**
How influential root metaphors for the learner, knowledge, and learning processes become embodied in educational technologies, and how the sociocultural context of their design and use influences their appropriation or rejection.

**LRN_SCI 499-0 Independent Study (1-3 Units)**
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

**LRN_SCI 519-0 Responsible Conduct of Research Training (0 Unit)**

**LRN_SCI 590-0 Research (1-3 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit. - SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

**Legal Studies (LEGAL_ST)**

**LEGAL_ST 499-0 Independent Study (1 Unit)**
Readings and conferences on special subjects for graduate students pursuing a specific area of interest in legal studies.

**Linguistics (LING)**

**LING 300-0 Topics in Linguistics (1 Unit)**
Topics in linguistic theory. Content varies. May be repeated for credit with different topic.

**LING 311-0 Child Language (1 Unit)**
Introduction to first-language acquisition. How infants and children learn the grammar (structure of sounds, words, and sentences) of their native language. Innate and environmental factors in linguistic development. Emphasis on experimental and corpus-based methods of inquiry.

**Social Behavioral Sciences Distro Area**

**LING 315-0 Experimental Approaches to Word Form Processing (1 Unit)**
Experimental techniques and theoretical models for analyzing perception and production of spoken and written word forms. Access to the mental lexicon in perception and production.

Prerequisite: LING 250-0 or consent of instructor.

**Social Behavioral Sciences Distro Area**

**LING 316-0 Experimental Syntax (1 Unit)**
Experimental methodologies and theories of sentence comprehension. Studies of syntactic structures in sentence comprehension.

Prerequisite: LING 260-0 or consent of instructor.

**Social Behavioral Sciences Distro Area**

**LING 317-0 Experimental Pragmatics (1 Unit)**
Experimental methodologies for analyzing the role of context in utterance production and comprehension.

Prerequisite: LING 270-0 or consent of instructor.

**Social Behavioral Sciences Distro Area**

**LING 320-0 Sociolinguistics (1 Unit)**
Overview of classic and contemporary work in sociolinguistics. How quantitative methods in linguistics can be coupled with social theoretic insights to engage questions in linguistic variation and change, stylistic practice, how language reflects, reinforces, or contests social inequalities.

**Social Behavioral Sciences Distro Area**

**LING 321-0 Bilingualism (1 Unit)**
Cognitive, linguistic, neuroscientific, and computational aspects of the acquisition, representation, and processing of two or more languages in an individual’s mind/brain.

Prerequisite: LING 250-0, LING 260-0, or LING 270-0.

**Social Behavioral Sciences Distro Area**

**LING 330-0 Research Methods in Linguistics (1 Unit)**
Methods of linguistic data collection, management, and analysis with an emphasis on the use of computational, experimental, and statistical methods.

Social Behavioral Sciences Distro Area

LING 334-0 Introduction to Computational Linguistics (1 Unit)
Hands-on introduction to computational methods in empirical linguistic analysis and natural language processing.

Formal Studies Distro Area

LING 336-0 Words, Networks and the Internet (1 Unit)
Word networks and language on the Internet. Python tools for exploring spam, search engines, and social media.
Prerequisite: LING 330-0, LING 334-0, LING 361-0, or equivalent background.

Formal Studies Distro Area

LING 341-0 Language Typology (1 Unit)
A comparison of varying and universal features of the world's languages.
Prerequisite: LING 250-0, LING 260-0, or LING 270-0.

Formal Studies Distro Area

LING 342-0 Structure of Various Languages (1 Unit)
Phonological, morphological, or syntactic structure of a particular language. May be repeated for credit with change in language.

Formal Studies Distro Area

LING 350-0 Fundamentals of Laboratory Phonology (1 Unit)
Prerequisite: LING 250-0 or consent of instructor.

Natural Sciences Distro Area

LING 360-0 Fundamentals of Syntax (1 Unit)
Fundamental principles of theoretical syntax. Phrase structure, argument structure, movement operations. Emphasis on argumentation, hypothesis formation and testing, and analytic methods.
Prerequisite: LING 260-0 or consent of instructor.

Formal Studies Distro Area

LING 361-0 Morphology (1 Unit)
Issues in theoretical morphology. The internal structure of words. Linguistic and psycholinguistic findings about the representation and processing of word structures.
Prerequisite: LING 250-0, LING 260-0, or LING 270-0.

Formal Studies Distro Area

LING 370-0 Fundamentals of Meaning (1 Unit)
Theoretical approaches to the study of linguistic meaning. Topics include word meaning, argument and event structure, sentence meaning, truth conditions, and inference types (e.g., entailment, implicature, presupposition).
Prerequisite: LING 270-0 or consent of instructor.

Formal Studies Distro Area

LING 372-0 Pragmatics (1 Unit)
Introduction to extra-semantic meaning, focusing on the role of context in utterance production and interpretation. Topics include the semantics-pragmatics boundary, implicature, presupposition, speech acts, reference, and information structure.
Prerequisite: LING 250-0, LING 260-0, or LING 270-0.

LING 373-0 Implicature (1 Unit)
An interdisciplinary approach to the study of extra-semantic meaning, drawing on primary readings from linguistics, philosophy, and psychology. Topics include conversational and conventional implicature, explication, impliciture, and the semantics-pragmatics boundary.
Prerequisite: LING 370-0, LING 372-0, or consent of instructor.

Social Behavioral Sciences Distro Area

LING 380-0 Spoken English for Non-Native Speakers (0 Unit)
Conversational English addressing all oral language skills; primarily for international graduate students who are nonnative speakers of English.
Content varies.

LING 381-0 Written English for Non-Native Speakers (0 Unit)
Written argumentation skills and all aspects of academic writing; primarily for international graduate students who are nonnative speakers of English.

LING 400-0 Seminar in Linguistics (1 Unit)
Theoretical issues of current concern to linguistics. Topics vary. May be repeated for credit with change of topic.

LING 450-1 Laboratory Phonology I (1 Unit)
Prerequisite: LING 350-0 or permission of instructor.

LING 450-2 Laboratory Phonology II (1 Unit)
Prerequisite: LING 450-1 or permission of instructor.

LING 451-0 Proseminar in Sound Structure (1 Unit)
Detailed study of a particular empirical issue (e.g., intonation, syllable structure) or theory (e.g., Optimality Theory, Articulatory Phonology) in phonology/phonetics.
Prerequisites: LING 450-2 or permission of instructor.

LING 452-0 Seminar in Sound Structure (1 Unit)
Advanced topics in phonological theory.
Prerequisites: LING 450-2 or permission of instructor.

LING 460-1 Syntactic Analysis I (1 Unit)
Formal syntactic analysis within generative grammar, focusing on universal and language-specific properties, argumentation. Topics include phrase structure, sentential complementation, anaphora, island constraints, and the lexicon.
Prerequisites: LING 360-0 or permission of instructor.

LING 460-2 Syntactic Analysis II (1 Unit)
Continuation of LING 460-1.
Prerequisites: LING 460-1 or permission of instructor.

LING 461-0 Proseminar in Syntax (1 Unit)
Detailed study of a particular empirical issue (e.g., clause structure, ellipsis, pronoun/antecedent relations) or theory (e.g., the Minimalist Program, Lexical-Functional Grammar) in syntax.
Prerequisites: LING 460-2 or permission of instructor.

LING 462-0 Seminar in Syntax (1 Unit)
Advanced topics in syntactic theory.
Prerequisites: LING 460-2 or permission of instructor.

LING 470-1 Semantic Analysis I (1 Unit)
Formal analysis of linguistic meaning, with a focus on compositional and contextual aspects of interpretation. Topics include the syntax-semantics interface, quantification, intensionality, anaphora, and dynamic semantics.
Prerequisites: LING 370-0 or permission of instructor.

LING 470-2 Semantic Analysis II (1 Unit)
Continuation of LING 470-1.
Prerequisites: LING 470-1 or permission of instructor.

LING 471-0 Proseminar in Semantics (1 Unit)
Detailed study of a particular empirical issue (e.g., presupposition, quantification, aspect, conditionals) or theory (e.g., dynamic semantics, discourse representation theory) in semantics/pragmatics. Prerequisites: LING 470-2 or permission of instructor.

LING 472-0 Seminar in Semantics (1 Unit)
Focused study of current issues in formal semantics and their implications for linguistic theory. Prerequisites: LING 470-2 or permission of instructor.

LING 473-0 Seminar in Pragmatics (1 Unit)
Advanced topics in pragmatic theory. Prerequisites: Permission of instructor.

LING 480-0 American Academic Culture for Non-Native speakers of English (0 Unit)
This course explores effective academic communication in the American undergraduate classroom through observation, analysis, and practice. The emphasis is on developing students' oral English proficiency while preparing them for success as instructors and teaching assistants. Students will explore communication skills such as: effective lecturing/presenting, leading classroom discussions, leading in-class activities, and presenting administrative information to students. More generally, students in this course will receive guidance in preparing for The Graduate School's live teaching demonstration assessment. Those who earn a "satisfactory" grade in the course will be eligible to participate in this demonstration, which is one means of fulfilling The Graduate School's English proficiency requirement.

LING 482-0 Individual Speech and Language Instruction for Nonnative Speakers of English (0 Unit)
Individual language study with a trained tutor for the purpose of increasing nonnative speakers' ability to communicate effectively in English in academic and everyday contexts.

LING 483-0 Supported Online Speech Training for Nonnative Speakers of English (0 Unit)
Native Accent Speech Training for Nonnative Speakers of English. Online speech training for the purpose of increasing nonnative speakers' intelligibility in oral English.

LING 489-0 Applied Linguistics for English Language Teaching (1 Unit)
This course provides a theoretical and practical knowledge base for teaching English as a second or foreign language. Students will first read and discuss research from the fields of second language acquisition, applied linguistics, and second language pedagogy to become conversant with present and past issues in the field. Students will learn best practices for assessment of second language skills and create course plans for differentiated instruction in individual and group settings, using their own teaching materials and approach. They will observe class groups; lead discussions on current applied linguistics research; complete linguistic analysis and learning goals for individual adult English language learners; apply and present linguistic and pedagogical theory for presentation to non-linguists; develop and conduct group activities. During the SPEAK training sessions and lab sessions, students will become trained to rate English proficiency using the SPEAK test. Prerequisite: LING 350-0.

LING 499-0 Independent Study (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

LING 500-0 Research Seminar (1 Unit)
Forum for presenting and discussing student research; for second-year graduate students in linguistics working on the research paper requirement. Pass/no-credit registration required.

LING 519-0 Responsible Conduct of Research Training (0 Unit)
LING 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Management and Organizations (MORS)

MORS 499-0 Independent Study (1 Unit)
Students who have established superior records and who wish to study more in depth than what is provided in regular courses may register for independent study with a selected instructor. Permission of the instructor and the department is required.

MORS 521-1 Special Topics in Management & Organizations: Micro (1 Unit)
The course covers classic and recent research topics in micro-oriented areas of Management and Organizations. Topics are drawn from social psychology, organizational behavior, and micro-organizational research methods.

MORS 521-2 Special Topics in Management and Organizations: Macro (1 Unit)
The course covers classic and recent research topics in macro-oriented areas of Management and Organizations. Topics are drawn from sociology, organizational theory, and macro-organizational research methods.

MORS 524-1 The Individual and the Organization (1 Unit)
Individual behavior in organizational settings. Topics include recent theory and research on social cognition, decision making, negotiation, groups, norms, fairness, and equity theory.

MORS 524-2 Social Processes in Organizations (1 Unit)
Group behavior in organizational settings. Topics include recent theory and research on group formation, social influence, group composition, group performance, group decision making, diversity, coalitions, intergroup relations and social dilemmas.

MORS 525-1 Behavior in Organizational Systems (1 Unit)
Theory construction, with effort at verification, drawing on empirical studies. Macro-level analysis of internal organizational system problems such as goals, structure, roles, power, authority, communications, and controls.

MORS 525-2 Organizations in Their Environments (1 Unit)
Analysis of organizations as open systems in relation to social, cultural, political and economic environments. The course covers classical, canonical and contemporary approaches in management research and organizational sociology, as well as selective research in other disciplines.

MORS 526-1 Micro-Organizational Research Methods (1 Unit)
This course provides an introduction to research designs and methods for "micro" research in organizations. The purpose to develop students' skill at designing, executing, interpreting, and evaluating micro-organizational and social psychological research. The course addresses both theoretical and practical considerations of research methods, with a special focus on the role of laboratory experiments and other common methods in behavioral research.

MORS 526-2 Macro-Organizational Research Methods (1 Unit)
This course examines the empirical research methods commonly used to test key concepts in macro-organizational theory. It focuses on developing doctoral students' skills in (1) identifying interesting research questions, (2) linking them creatively and appropriately to specific
Managerial Econ & Strategy (MECS)

MECS 499-0 Independent Study (1 Unit)

MECS 540-1 Political Economy I: Budget Deficits: A Political Economy View (1 Unit)
This course reviews the economic and political-economic literature on budget deficits. We cover theoretical and empirical papers on topics including: economic and politico-economic models of government debt; the impact of debt on growth; the effect of fiscal rules; and sovereign defaults, with emphasis on recent developments. The course is complementary with Public Finance and Macro.

MECS 540-2 Political Economy II: Conflict and Cooperation (1 Unit)
This course offers a theoretical treatment of conflict. Conflict often arises even though there is some cooperative solution that would have satisfied all the relevant actors. The course studies the fundamental causes of conflict (positive analysis) and possible solutions that create cooperation (normative analysis). This course might be of interest to students in applied theory, political economy or development.

MECS 540-3 Political Economy III: Social Choice and Voting Models (1 Unit)
This course is about aspects of collective decision-making, both on the micro level and macro level. We briefly review some classic results from social choice, then strategic behavior in collective decision-making. The next topic is a discussion of all aspects of elections, ending with analysis of institutions. We study models of forward-looking behavior in collective decision-making and dynamics of institutions.

MECS 540-4 Political Economy IV: Topics in Development Economics (1 Unit)
This course introduces PhD students to three important topics within development economics and political economy, reviewing the frontier of the literature, the latest questions, methods most prevalently used, and the evidence thus far. The class focuses on empirical methods and their connection with theory. The course goal is assisting students as they transition into the research phase of their career.

MECS 541-1 Technology and Innovation I (1 Unit)
Technology and Innovation examines the characteristics and application of technology. The course considers sources and measurement of technological change, covering research and development and invention; innovation; and diffusion of technology. The course is a seminar with lectures and class discussion and is open to Ph.D. students in the Kellogg School of Management, Social Sciences, and the McCormick School of Engineering.

MECS 541-2 Technology and Innovation II (1 Unit)
This course establishes fundamental ways in which ideas differ from other goods, then uses these concepts to evaluate the origins of innovation, economic growth, firm dynamics, entrepreneurship, innovation clusters, and the diffusion of new technology. The course substantially reviews core empirical literature, including methods and data sets that are suited to studying ideas and innovation.

MECS 550-1 Economic Theory I: Decision Theory (1 Unit)
This course focuses on decision theory and formal theories of individual decision making, with emphasis on decision making under risk/uncertainty. We explore utility theory under certainty, then classic expected utility theories. Following is a review a selection expanding on the classical work in various directions, closer to the current research frontier. The selection covered may vary with available time/interests.

MECS 550-2 Economic Theory II: Advanced Topics in Game Theory (1 Unit)
This course deeply covers a current research area in game theory with recent, fruitful developments. Besides covering the topic, the course provides students perspective over an entire subliterature. Students see how a field developed over time, consider alternative development options, and learn what early work influenced followup research. Instructors focus on topics for which they have expertise and active research.

MECS 550-3 Economic Theory III: Doing Research in Economic Theory and Related Areas (1 Unit)
This course assists students in transitioning to the role of researchers via exploration and development of research topics. The first half uses professor-chosen topics, focusing on cutting edge theoretical/experimental work in Contracts, Incentives, and Mechanism Design. The course then focuses on student-chosen areas. Students benefit both from instructor assistance and the process of making/receiving comments from other students.

MECS 551-1 Health Economics I (1 Unit)
This course will expose students to both seminal and cutting edge research in health economics. The pedagogy includes lecture, student presentations of research papers, and original student projects. Prerequisites: ECON 410-1, ECON 410-2, ECON 410-3 (Microeconomics); ECON 480-1, ECON 480-2, ECON 480-3 (Introduction to Econometrics); MECS 551-1 is required before enrolling in MECS 551-2.

MECS 551-2 Health Economics II (1 Unit)
This course will expose students to both seminal and cutting edge research in health economics. The pedagogy includes lecture, student presentations of research papers, and original student projects. Prerequisites: ECON 410-1, ECON 410-2, ECON 410-3 (Microeconomics); ECON 480-1, ECON 480-2, ECON 480-3 (Introduction to Econometrics); MECS 551-1 is required before enrolling in MECS 551-2.

MECS 560-1 Static Optimization in Economics (1 Unit)
This course provides essential tools for those planning to create or apply economic theory. The course can be divided very broadly into feasibility, optimization, and fixed-point theory. More specific topics include linear programming, Karush-Kuhn-Tucker conditions, Brouwer and Kakutani fixed-point theorems, and supermodularity, with illustrations of uses in finance, game theory, general equilibrium, and matching.

MECS 560-2 Dynamic Optimization in Economics (1 Unit)
The goal of this course is to introduce students to dynamic optimization techniques for both discrete and continuous time stochastic problems. In particular, the course will present results in discrete time dynamic programming and consider their applications in a range of topics. Specific examples include search models, bandit problems, and dynamic games.

MECS 560-3 Research in Economics (1 Unit)
This course introduces first-year PhD students to the economics research environment. With an emphasis on breadth, and minimal prerequisite knowledge at the graduate level, students are exposed to the process of forming and answering research questions. The course involves multiple faculty providing their perspective on successful approaches to research by highlighting significant recent works in their respective fields of interest.

MECS 570-1 Economics of Organizations I: Organizations and Markets (1 Unit)
This course provides an introduction to the economics of organizations. To this end, it covers a variety of topics including incentives in organizations; delegation, cheap talk, and adaptation; firm boundaries, structures, and processes. In order to understand how organizations interact in markets and influence the broader economy, we cannot view organizational practices as completely divorced from the underlying economic context.

**MECS 570-2 Economics of Organizations II: Organizational Dynamics (1 Unit)**
Practices and productivity vary both across organizations and over time, generating substantial and persistent dispersion in firm performance even within narrowly-defined industries. This course expands the discussion started in Organizational Economics I to address how these differences emerge, why they might persist. Topics include dynamic incentive provision and adaptation; hiring, promotion, turnover, other personnel policies; managerial practices and organizational performance.

**MECS 590-0 Research (3 Units)**

### Marketing (MKTG)

**MKTG 499-0 Independent Study (1 Unit)**
Students with superior records who wish to study some significant phase of marketing in more depth than is provided in regular courses may register for independent study with a selected instructor. Permission of the instructor and department are required.

**MKTG 531-1 Theory Building in Consumer Behavior Research (1 Unit)**
The purpose of this course is to acquaint you with the principles of theory building in social science research, to help you distinguish between theory-building research and research with other aims, and to provide you with an opportunity to develop your ability to conceptualize and develop research that builds theory.

**MKTG 531-2 Methods and Data in Consumer Research (1 Unit)**
This course focuses on three topics: (1) how to formulate and test interaction effects with continuous and discrete factors in experimental designs; (2) how to perform meta-analyses of multiple as well as single (e.g., your) papers; and (3) how to conduct and interpret mediation analyses. Techniques that facilitate reproducible manuscripts which integrate text, data analyses, and statistical outputs are emphasized.

**MKTG 531-3 Developing Impactful Consumer Research (1 Unit)**
Taking a problem-solving approach, we examine how psychological insights inform and solve real-world consumption problems, and how real-world problems provide new psychological insights. Taking an empirical deep-dive, we also discuss published data, what we can/cannot infer, how to make objective conclusions, and to enhance their substantive impact (e.g., employing observational data, field studies, choice data, and/or programmatic experimental designs).

**MKTG 540-0 Special Topics in Consumer Research (1 Unit)**
This course introduces students to new topics and approaches in consumer behavior research. As such, the topics will change from year to year, and students will be challenged to further develop the theoretical model proposed in the papers. Besides being relevant to marketing students, this course is likely of interest to graduate students in psychology, communication studies and education.

**MKTG 550-0 Quantitative Marketing: Analytic Modeling (1 Unit)**
Analytic models are used across many areas of marketing including strategy, pricing, product design, channel management, and sales force compensation to provide insight into the impact of market forces, competition, consumers, and firm choices on outcomes such as profit, sales, and welfare. In this course, we cover what analytic models are, their purposes, and how to build and analyze them.

**MKTG 551-1 Quantitative Marketing: Introduction to Theory and Empirical Methods (1 Unit)**
This survey course introduces students to substantive and methodological issues in quantitative marketing. We cover ~6 weeks of material on substantive issues such as pricing, advertising, peer effects, and word of mouth. We also cover ~4 weeks of material on methods of causal inference. The readings are multidisciplinary and include topics from marketing, psychology, microeconomics, operations management, and macroeconomics.

**MKTG 551-2 Quantitative Marketing: Statistical Modeling (1 Unit)**
This is a doctoral course on statistical models and topics alternate from year to year. Currently, in odd years the course is on Bayesian methods and computation while in even years the course is on applied and computational statistics. Marketing applications include but are not limited to conjoint analysis, choice models, data minimization, perceptual maps, etc.

**MKTG 551-3 Quantitative Marketing: Structural Modeling (1 Unit)**
This course provides a foundational understanding of static and dynamic discrete-choice models, with applications drawn from quantitative marketing and economics. The course takes a "hands on" approach to research, with class being a mix of lectures, discussion of articles, and hands-on empirical analysis. Coding assignments are the bulk of the grade.

**MKTG 552-0 Topics in Quantitative Marketing (1 Unit)**
This seminar required of 2nd-4th year students exposes students to working papers in current areas of active research. Students read, present, and discuss recent papers with the goal of improving their ability to evaluate a paper's academic contribution and managerial relevance and to further extend their knowledge of models and methods.

**MKTG 560-0 Marketing Strategy (1 Unit)**
The seminar covers topics in marketing strategy and marketing management, including the development of marketing, the concept of marketing, the impact of marketing strategy on firm performance, order of entry and competitive advantage, branding, and market orientation. The focus is on major advances in each area, relevant research in related disciplines, and current areas of interest.

**MKTG 590-0 Research (3 Units)**
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

### Master of Science in Clinical Investigation (MSCI)

**MSCI 311-0 Clinical Research Design, Methods, and Grant Writing (1 Unit)**
This course presents students with a comprehensive survey of concepts vital to a career in clinical & translational science. The course will fill a void in the curriculum by functioning as foundation from which other MSCI courses will spring and afford students an opportunity to interface with basic clinical and translational concepts before delving into these subjects more granularly as they pursue the degree. Items that will be reviewed in more depth later such as reviewing study designs and recognizing the types of research problems that lend themselves to interventional study designs are approached here as a way of better preparing students for the challenges ahead.

**MSCI 321-1 Biostatistics for Clinical Investigators 1 (1 Unit)**
This is an introductory yet rigorous course that covers classic statistical inference and methods. Applications and interpretation of data are emphasized. Mathematical proofs and derivations are not covered; however, theory is addressed conceptually. Readings are intended to be theoretical. Lectures, homework and exams will focus on applying statistical procedures using SPSS and interpreting data. Due to time restrictions, only selected topics are covered. The use of SPSS is a course requirement.

MSCI 330-0 Electronic Health Record Data as a Foundation for Clinical Research (1 Unit)
This course will introduce electronic health records as a data source, considerations for working with protected health information and integration of health record data with other data sources and will explore clinical and research applications of medical records and discuss methods and tools for data validation and analysis.

MSCI 335-0 Clinical Trials (1 Unit)
The goal of this course is to provide students with the skills to design, conduct, analyze, interpret, and report the rest of a clinical trial. Trials by definition are experimental and are used to determine whether a clinical intervention works.

MSCI 421-0 Biostatistics for Clinical Investigators 2 (1 Unit)
This course covers advanced modeling techniques for statistical inference. Applications and interpretation of data are emphasized. Mathematical proofs and derivations are not covered; however, theory is addressed conceptually. Lectures, homework and exams will focus on applying statistical procedures using SPSS and interpreting data. Due to time restrictions, only selected topics are covered. The use of SPSS is a course requirement.

MSCI 422-0 Introduction to Translational Research (1 Unit)
This course is intended to introduce the basic life sciences graduate student to the thought processes involved in human disease research by providing an overview of disease processes, how they are treated, and how basic biological science is used to develop those treatments.

MSCI 445-0 Writing & Peer Reviewing for Publication for Clinical Investigators (1 Unit)
This course represents a HANDS-ON experience that will review and discuss the steps involved in preparing, peer reviewing, and revising manuscripts for publication. Students are expected to prepare and hand in written work for each class and to attend and participate actively in class discussion. Advance reading and writing are essential for this course.

MSCI 490-0 Independent Study (1 Unit)
Permission of instructor and department required.

MSCI 499-0 Research Project (2 Units)
The MSCI Research Project serves as a capstone for the degree; students enroll at or near the end of their coursework and signifies the culmination of a project that they have been working on throughout their time in the program. This is not a traditional classroom course but follows an independent study approach. Research must be data-driven and of publishable quality; clinical case studies or IRB submissions are not acceptable.

Materials Science & Engineering (MAT_SCI)

MAT_SCI 314-0 Thermodynamics of Materials (1 Unit)
Classical and statistical thermodynamics; entropy and energy functions in liquid and solid solutions, and their applications to phase equilibria. Lectures, problem solving. Materials science and engineering degree candidates may not receive credit for 314 with or after CHEM 342-1. Prerequisite: CHEM 132-0, CHEM 152-0, or CHEM 172-0; MATH 228-1; or PHYSICS 135-1 or equivalent.

MAT_SCI 315-0 Phase Equilibria & Diffusion of Materials (1 Unit)

MAT_SCI 316-1 Microstructural Dynamics (1 Unit)
Principles underlying development of microstructures. Defects, diffusion, phase transformations, nucleation and growth, thermal and mechanical treatment of materials. Lectures, laboratory. Prerequisite: MAT_SCI 315-0 or equivalent.

MAT_SCI 316-2 Microstructural Dynamics (1 Unit)
Principles underlying development of microstructures. Defects, diffusion, phase transformations, nucleation and growth, thermal and mechanical treatment of materials. Lectures, laboratory. Prerequisite: MAT_SCI 315-0 or equivalent.

MAT_SCI 318-0 Materials Selection (1 Unit)
Methods of specifying materials and the processes for making them in the context of a given application. Service performance of materials based on their physical and chemical properties. Case studies and use of high-level databases. Prerequisite: MAT_SCI 201-0 or equivalent.

MAT_SCI 331-0 Soft Materials (1 Unit)
Different kinds of polymeric materials. Relationships between structure and physical properties; rubber elasticity, the glassy state, crystallinity in polymers. Lectures, laboratory. Prerequisites: MAT_SCI 301-0 or equivalent; MAT_SCI 316-0 or CHEM 342-1; MAT_SCI 316-1 and MAT_SCI 316-2 highly recommended.

MAT_SCI 332-0 Mechanical Behavior of Solids (1 Unit)
Plastic deformation and fracture of metals, ceramics, and polymeric materials; structure/property relations. Role of imperfections, state of stress, temperatures, strain rate. Lectures, laboratory. Prerequisites: MAT_SCI 316-1; MAT_SCI 316-2, may be taken concurrently; CIV_ENV 216-0 or consent of instructor.

MAT_SCI 333-0 Composite Materials (1 Unit)
Introduction to ceramic, metal, polymer-matrix composites for structural applications. Emphasis on structure (reinforcements, architecture), properties (elasticity, strength, toughness, creep), processing, role of interface. Prerequisites: MAT_SCI 316-1, MAT_SCI 316-2, MAT_SCI 332-0.

MAT_SCI 336-0 Chemical Synthesis of Materials (1 Unit)
The design of materials targeting important properties through processes that break and form primary chemical bonds. Fundamental principles and main methodologies, including polymerization, biosynthesis, self-assembly, solgel reactions, synthesis of nanomaterials, vapor-phase synthesis, and composite synthesis.
Prerequisite: junior standing in materials science and engineering or consent of instructor.

**MAT_SCI 337-0 Conducting Polymers (1 Unit)**
Fundamentals and applications of conducting polymers. Hands-on experience in synthesizing conducting polymer nanostructures. Prerequisite: MAT_SCI 331-0 or consent of instructor.

**MAT_SCI 340-0 Ceramic Processing (1 Unit)**
Steps in production of fired ceramic articles. Powder preparation and characterization, compact formation, slip casting, extrusion and injection molding; firing, liquid-phase and solid-state sintering. Lectures, laboratory. Prerequisite: MAT_SCI 316-1 or equivalent.

**MAT_SCI 341-0 Introduction to Modern Ceramics (1 Unit)**
Applications of ceramic materials, with emphasis on structure (bond, crystal, glass, defect, micro-); properties (thermal, electrical, optical, magnetic, mechanical); and processing (powders, forming, densification). Prerequisites: MAT_SCI 316-1, MAT_SCI 316-2 or consent of instructor.

**MAT_SCI 351-1 Introductory Physics of Materials (1 Unit)**
Quantum mechanics; applications to materials and engineering. Band structures and cohesive energy; thermal behavior; electrical conduction; semiconductors; amorphous semiconductors; magnetic behavior of materials; liquid crystals. Lectures, laboratory, problem solving. Prerequisites: MAT_SCI 301-0 or equivalent or consent of instructor; GEN_ENG 205-4 or equivalent; PHYSICS 135-2, PHYSICS 135-3; MAT_SCI 351-1 is prerequisite for MAT_SCI 351-2.

**MAT_SCI 351-2 Introductory Physics of Materials (1 Unit)**
Quantum mechanics; applications to materials and engineering. Band structures and cohesive energy; thermal behavior; electrical conduction; semiconductors; amorphous semiconductors; magnetic behavior of materials; liquid crystals. Lectures, laboratory, problem solving. Prerequisites: MAT_SCI 301-0 or equivalent or consent of instructor; GEN_ENG 205-4 or equivalent; PHYSICS 135-2, PHYSICS 135-3; MAT_SCI 351-1 is prerequisite for MAT_SCI 351-2.

**MAT_SCI 353-0 Bioelectronics (1 Unit)**
Development and design of sensors, stimulators, and their medical devices for biointegrated electronics. Materials design and fabrication of passive and active components for sensitive, multimodal, and robust wearable and implantable devices.

**MAT_SCI 354-0 Bioelectronics Lab (0.34 Unit)**
Laboratories focused on the practical implementation, instrumentation, and fabrication of wearables and skinsensing. Applications range from vital sign monitoring to rehability.

**MAT_SCI 355-0 Electronic Materials (1 Unit)**
Principles, models, and characterization of semiconductor materials. Crystal growth and doping. Diffusion, epitaxy, and monolithic processes. Current transport, non-equilibrium processes, thin films, low-mobility materials, and interfaces. Prerequisite: MAT_SCI 316-1 or consent of instructor.

**MAT_SCI 357-0 Nanomagnetic Materials for Information Storage (1 Unit)**
Overview of materials used for magnetic data storage and of the recording and read processes. Information storage systems, such as optical, solid-state, and probe. Theoretical background for understanding the four energy terms that control the properties of magnetic materials when they are patterned at the nanoscale.

**MAT_SCI 360-0 Introduction to Electron Microscopy (1 Unit)**
Theories and practice involved in application of scanning electron microscopy and transmission electron microscopy. Lectures, laboratory.

**MAT_SCI 361-0 Crystallography & Diffraction (1 Unit)**
Elementary crystallography. Basic diffraction theory; reciprocal space. Applications to structure analysis, preferred orientation. Film and counter techniques. Lectures, laboratory.

**MAT_SCI 362-0 Point, Line & Planar Imperfections (1 Unit)**
Introduction to point defects, dislocations, and internal interfaces in crystalline solids. Interactions among point, line, and planar imperfections. Metals, ionic solids, semiconductors. Prerequisite: MAT_SCI 315-0.

**MAT_SCI 370-0 Biomaterials (1 Unit)**
Introduction to biomaterials from a materials science perspective, focusing on synthesis, structure, and properties. Materials used for human repair (permanent implants, devices, materials for drug delivery, tissue-engineering scaffolds); naturally occurring and engineered materials synthesized through biotechnology: biomimetic materials that copy microstructures from nature. Taught with BMD_ENG 343-0; may not receive credit for both courses.

**MAT_SCI 371-0 Biominerals: Hierarchical Architecture & Function (1 Unit)**
How biologically based processing of inorganic/organic composites used by living organisms inspires new approaches to materials synthesis in many critical applications: locomotion (bones), defense (shells), and sensing (light, acceleration, magnetic fields). Prerequisite: MAT_SCI 316-2 or equivalent, or consent of instructor.

**MAT_SCI 376-0 Nanomaterials (1 Unit)**
Introduction to structure-property relationships of materials processed at the nanometer scale. Highly interdisciplinary course appropriate for undergraduate and graduate students in other departments. Prerequisite: MAT_SCI 351-1 or consent of instructor.

**MAT_SCI 380-0 Intro Surface Science & Spectroscopy (1 Unit)**
Surface spectroscopy, including Auger spectroscopy, photoemission, and LEED. Surface dynamics and thermodynamics. Electronic properties of surfaces and interfaces. Gas-surface interactions. Prerequisite: MAT_SCI 351-1 or equivalent.

**MAT_SCI 381-0 Materials for Energy-Efficient Technology (1 Unit)**
A materials science approach to the challenges of energy efficient technology: energy content of materials; advanced materials for energy harvesting, transmission, storage, and conversion; materials for energy efficient transportation and housing. Term paper and oral presentation. Prerequisite: MAT_SCI 201-0, MAT_SCI 301-0, or consent of instructor.

**MAT_SCI 382-0 Electrochemical Energy Materials and Devices (1 Unit)**
Thermodynamics and kinetics of electrochemical processes. Materials for fuel cells, batteries, and electrochemical capacitors, including electrolytes and electrodes. Electrical and mass transport. Effect of microstructure. Electrochemical characterization. Device configurations. Prerequisite: senior standing or consent of instructor.

**MAT_SCI 390-0 Materials Design (1 Unit)**
Analysis and control of microstructures. Quantitative process/structure/property/performance relations, with case studies. Computer lab for modeling multicomponent thermodynamics and transformation kinetics. Prerequisites: MAT_SCI 315-0, MAT_SCI 316-1, MAT_SCI 316-2, or consent of instructor.

**MAT_SCI 391-0 Process Design (1 Unit)**
Processing of materials. Design and analysis of experiments to identify and optimize key parameters to control properties and performance. Resolving conflicting requirements. Statistical process control. Prerequisite: MAT_SCI 316-1 or equivalent.

**MAT_SCI 395-0 Special Topics in Materials Science and Engineering (1 Unit)**
Topics suggested by students or faculty and approved by the department.

**MAT_SCI 397-0 Special Topics in Materials Science and Engineering (0.34 Unit)**
Special Topics in Materials Science and Engineering, Laboratory emphasis.

**MAT_SCI 401-0 Chemical & Statistical Thermodynamics of Materials (1 Unit)**
Chemical thermodynamics via analytical and statistical approaches, including chemical potentials, conditions for equilibrium, distribution functions, ideal and regular solutions, and phase diagrams. Graduate core course.

**MAT_SCI 402-0 Structure of Crystalline and Noncrystalline Materials (1 Unit)**
Descriptors of material structure for crystalline and noncrystalline materials. Constitutive relationships described by tensors of rank 1 to 4. Classes of materials.

**MAT_SCI 404-0 Imperfections in Materials (1 Unit)**
Point, line, and planar imperfections in metals and ionic and semiconducting crystals. Diffusion. Interactions between crystal imperfections. Graduate core course.

**MAT_SCI 405-0 Physics of Solids (1 Unit)**
Reciprocal lattice representation, diffraction, Brillouin zone construction, bonding, lattice vibrations, phonon dispersion, and energy band structure of solids. Graduate core course.

**MAT_SCI 406-0 Symmetry and Mechanical Properties of Materials (1 Unit)**
Point group symmetry of crystals and the symmetry of properties; stress and strain tensors, piezoelectricity, elasticity, low- and high-temperature deformation of crystalline and non-crystalline materials, fatigue, and fracture. Graduate core course.

**MAT_SCI 408-0 Phase Transformations in Materials (1 Unit)**
Surfaces and interfaces, thermodynamics of phase transformations, nucleation, growth of precipitates, coarsening, and spinodal decomposition. Graduate core course.

**MAT_SCI 411-0 Phase Transformations in Crystalline Materials (1 Unit)**
Advanced treatment of order-disorder transformations, spinodal ordering, effects of stress on transformations, and displacive transformations.

**MAT_SCI 415-0 Fundamentals of Thin Film Materials (1 Unit)**
Vapor-phase film deposition techniques, adsorption, nucleation mechanisms, selective deposition, structure, zone diagrams, epitaxy, and composition.

**MAT_SCI 416-0 Kinetics (1 Unit)**
Principles of Irreversible Thermodynamics; Driving Forces and Fluxes; Diffusion in the Presence of Stress; Diffusion Resulting from other Gradients; Diffusion Resulting from Discrete Jumps; Diffusion in Crystals; Diffusion Controlled versus Source/Sink Controlled Kinetics; Surface Rearrangements by Evaporation and Condensation; Coarsening of Microstructures due to Capillary Forces; Growth of Phases in Concentration Gradients; Growth of Phases in Thermal Gradients; Evaporation of Metal Crystals; Vapor-Liquid-Solid (VLS) Growth Mechanism of the Growth of Nanowires.

**MAT_SCI 434-0 Fracture of Brittle Solids (1 Unit)**
Theory and experimental results on fatigue and fracture of metals.

**MAT_SCI 435-0 High Temperature Materials (1 Unit)**
Current research fields such as environmental effects on mechanical behavior at elevated temperatures, advanced instrumentation, advanced techniques, and surface interactions.

**MAT_SCI 444-0 Organic Nanomaterials (1 Unit)**
The materials science and chemistry of soft nanomaterials for myriad applications including nanomedicine. Preparative and synthetic approaches to organized, assembled, discrete nanomaterials will be described. Course will include an in depth discussion of advanced characterization techniques and strategies for this class of material.

**MAT_SCI 445-0 Special Topics in High Polymer Science (1 Unit)**
Topics include application of statistical mechanics, morphology and crystallinity, spectroscopy, flow theory and molecular motion, and statistical theories of polymer composition and structure.

**MAT_SCI 451-0 Advanced Physics of Materials (1 Unit)**
Energy bands in solids, electronic conduction processes, dielectric properties, optical properties, semiconductors, magnetism, superconductivity, artificial structures, and amorphous materials.

**MAT_SCI 452-0 Selected Topics in the Solid State (1 Unit)**
Topics include electrical and optical properties of solids, magnetic properties, theory of solids, and surface and interface physics.

**MAT_SCI 455-0 Solid State Physics of Nanomaterials (1 Unit)**
Electrical, optical, and magnetic properties of reduced-dimensional materials and nanostructures.

**MAT_SCI 456-0 Functional Metamaterials (1 Unit)**
Ordered composite materials with properties distinct from those of the component building blocks. Structure-property relationships for designing metamaterials with electronic, optical, magnetic, and thermal functionality.

**MAT_SCI 458-0 Atomic Scale Computational Materials Science (1 Unit)**
Theory and application of atomic-scale computational materials tools to model, understand, and predict the properties of real materials.

**MAT_SCI 460-0 Electron Microscopy (1 Unit)**

**MAT_SCI 461-0 Diffraction Methods in Material Science (1 Unit)**

**MAT_SCI 465-0 Advanced Electron Microscopy & Diffraction (1 Unit)**
Theories of electron diffraction; theories of diffraction contrast and their application to lattice disorder, phase transformation. Current topics in electron and other charged-particle microscopy.

**MAT_SCI 466-0 Analytical Electron Microscopy (1 Unit)**
Diversity of analytical techniques in modern TEM, fundamental concepts in quantitative x-ray, EELS, CBED microanalysis, advanced AEM instrumentation, techniques and applications to physical and life sciences.

**MAT_SCI 471-0 Materials Biology (1 Unit)**
This class is addressed at graduate students with background in Engineering, Chemistry, and Physics, who want to acquire a working knowledge of key concepts in Biochemistry, Molecular, Cell and Developmental Biology. We will read both classical papers and modern literature, drilling down to the essentials hidden behind cryptic acronyms and exotic-sounding techniques. We will primarily work with literature.
that has relevance to Materials Science, in particular bio-inspired materials, but will also consider suggestions submitted by participants.

**MAT_SCI 485-0** Electronic and Thermal Properties of Materials (1 Unit)
Solid-state electronic structure from a solid-state chemistry perspective.

**MAT_SCI 495-0** Advanced Special Topics in Material Science (1 Unit)
Topics suggested by students or faculty and approved by the department.

**MAT_SCI 499-0** Projects (1 Unit)
Individual problems, including library or experimental work with a comprehensive report on some specific phase of materials science. PERMISSIONS OF INSTRUCTOR AND DEPARTMENT REQUIRED.

**MAT_SCI 510-0** Special Topics (1 Unit)
Topics may be suggested by students or faculty, with the approval of the department.

**MAT_SCI 590-0** Research (1-4 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS - Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**MAT_SCI 596-0** MS Thesis Research (1 Unit)
Research corresponding to MS thesis work for BS/MS students.

**Mathematics (MATH)**

**MATH 300-0** Foundations of Higher Mathematics (1 Unit)
Introduction to fundamental mathematical structures, including sets, functions, equivalence relations, and cardinal numbers. Elementary logic and proof techniques. Students may not receive credit for MATH 300-0 after passing any of MATH 320-1, MATH 321-1, MATH 330-1, or MATH 331-1.
Prerequisite: MATH 240-0 or MATH 281-3 or MATH 285-3 or MATH 290-3 or MATH 291-3 or MATH 291-1 or GEN_ENG 205-1 or GEN_ENG 206-1.
Recommended: MATH 320-1 or MATH 321-1.

**MATH 306-0** Combinatorics & Discrete Mathematics (1 Unit)
Discrete mathematics, inductive reasoning, counting problems, binomial coefficients and Pascal’s triangle, Fibonacci numbers, combinatorial probability, divisibility and primes, partitions, and generating functions.
Prerequisite: MATH 240-0 or MATH 281-3 or MATH 285-1 or MATH 290-1 or MATH 291-1 or GEN_ENG 205-1 or GEN_ENG 206-1 or consent of the department.
Formal Studies Distro Area

**MATH 308-0** Graph Theory (1 Unit)
Introduction to graph theory: graphs, trees, matchings, planar graphs, and colorings. Additional topics as time permits.
Prerequisite: MATH 291-1 or MATH 300-0 or MATH 306-0.
Formal Studies Distro Area

**MATH 310-1** Probability and Stochastic Processes (1 Unit)
Axioms of probability. Conditional probability and independence. Random variables. Joint distributions. Expectation. Limit theorems: the weak law of large numbers and the central limit theorem. Students may not receive credit for both MATH 310-1 and any of MATH 311-1, MATH 314-0, MATH 385-0, STAT 320-1, STAT 383-0, IEMS 202-0, or ELEC_ENG 302-0.
Prerequisite or Corequisite: MATH 228-2 or MATH 230-2 or MATH 234-0, or MATH 281-2 or MATH 285-3 or MATH 290-3 or MATH 291-3 or ES_APPM 252-2.
Formal Studies Distro Area

**MATH 310-2** Probability and Stochastic Processes (1 Unit)
Discrete-time Markov chains, recurrence and transience. Students may not receive credit for both MATH 310-2 and MATH 311-2.
Prerequisites: MATH 240-0 or MATH 281-3 or MATH 285-1 or MATH 290-1 or MATH 291-1 or GEN_ENG 205-1 or GEN_ENG 206-1; and MATH 310-1 or MATH 311-1 or MATH 314-0 or MATH 385-0 or STAT 320-1 or STAT 383-0 or IEMS 202-0 or ELEC_ENG 302-0.
Formal Studies Distro Area

**MATH 310-3** Probability and Stochastic Processes (1 Unit)
Continuous-time Markov chains, queues, population growth models. Brownian motion and other diffusion processes. Additional topics as time permits. Students may not receive credit for both MATH 310-3 and MATH 311-3.
Prerequisite: MATH 310-2 or MATH 311-2.
Formal Studies Distro Area

**MATH 311-1 MENU: Probability and Stochastic Processes (1 Unit)**
Probability spaces. Random variables. Independence. Distributions. Generating functions. The central limit theorem. Students may not receive credit for both MATH 311-1 and any of MATH 310-1, MATH 314-0, MATH 385-0, STAT 320-1, STAT 383-0, IEMS 202-0, or ELEC_ENG 302-0.
Recommended: MATH 320-1 or MATH 321-1.
Prerequisite: MATH 291-3; or MATH 300-0 and any one of MATH 290-3, MATH 281-2, MATH 285-3 or ES_APPM 252-2; or consent of the department.
Formal Studies Distro Area

**MATH 311-2 MENU: Probability and Stochastic Processes (1 Unit)**
Markov chains, convergence of random variables, random processes, renewals, and queues. Students may not receive credit for both MATH 311-2 and MATH 310-2.
Prerequisite: MATH 311-1 or consent of the department.
Formal Studies Distro Area

**MATH 311-3 MENU: Probability and Stochastic Processes (1 Unit)**
Stationary processes, martingales, and diffusion processes. Students may not receive credit for both MATH 311-3 and MATH 310-3.
Prerequisite: MATH 311-2 or consent of the department.
Formal Studies Distro Area

**MATH 314-0** Probability and Statistics for Econometrics (1 Unit)
Introduction to probability theory and statistical methods, including properties of probability distributions, sampling distributions, estimation, confidence intervals and hypothesis testing. For students planning to take ECON 381-1. Students may not receive credit for both MATH 314-0 and any of MATH 310-1, MATH 311-1, MATH 385-0, STAT 320-1, STAT 383-0, IEMS 202-0, or ELEC_ENG 302-0.
Prerequisite or Corequisite: MATH 228-2 or MATH 230-2 or MATH 234-0, or MATH 281-1 or MATH 285-3 or MATH 290-3 or MATH 291-3 or ES_APPM 252-2.
Formal Studies Distro Area

**MATH 320-1** Real Analysis (1 Unit)
Analysis on the real line: axiomatic development of the real number system, sequences and series of real numbers, continuity, and differentiability. Students may not receive credit for both MATH 320-1 and MATH 321-1.
Prerequisite: MATH 300-0 or MATH 291-3 or consent of the department.
Formal Studies Distro Area

**MATH 320-2** Real Analysis (1 Unit)
Analysis on the real line: the Riemann integral and sequences and series of functions. Additional topics as time permits. Students may not receive credit for both MATH 320-2 and MATH 321-2.
Prerequisite: MATH 320-1 or MATH 321-1.
Formal Studies Distro Area

**MATH 320-3** Real Analysis (1 Unit)
Analysis on Euclidean spaces: the topology of Euclidean spaces, limits, continuity, and differentiability, including the inverse and implicit function theorems. Additional topics as time permits. Students may not receive credit for both MATH 320-3 and MATH 321-2.

Prerequisite: MATH 320-2.

**Formal Studies Distro Area**

**MATH 321-1 MENU: Real Analysis (1 Unit)**

Analysis on metric spaces: the real number system, the topology of metric spaces, sequences and series, continuity, and differentiability. Students may not receive credit for both MATH 321-1 and MATH 320-1.

Prerequisite: consent of the department.

**Formal Studies Distro Area**

**MATH 321-2 MENU: Real Analysis (1 Unit)**

Analysis on metric spaces: the Riemann integral, sequences and series of functions, and functions of several variables, including the inverse and implicit function theorems. Students may not receive credit for both MATH 321-2 and either MATH 320-2 or MATH 320-3.

Prerequisite: MATH 321-1.

**Formal Studies Distro Area**

**MATH 321-3 MENU: Real Analysis (1 Unit)**

Lebesgue measure and the Lebesgue integral. Additional topics as time permits.

Prerequisite: MATH 321-2.

**Formal Studies Distro Area**

**MATH 325-0 Complex Analysis (1 Unit)**

Complex numbers. Analytic functions. Cauchy's theorem and the Cauchy integral formula. Series. Residues. Students may not receive credit for both MATH 325-0 and ES_APPM 312-0.

Prerequisites: MATH 228-2 or MATH 230-2 or MATH 234-0 or ES_APPM 252-2, and MATH 240-0 or GEN_ENG 205-1, or GEN_ENG 206-1; or MATH 281-3 or MATH 285-3 or MATH 290-3 or MATH 291-3.

**Formal Studies Distro Area**

**MATH 327-0 Mechanics for Mathematicians (1 Unit)**

Fundamental mathematical ideas arising in classical mechanics: Newtonian mechanics, Lagrangian formalism and the calculus of variations, motion with constraints, symmetries and conservation laws, and Hamiltonian mechanics, and Liouville's theorem. No prior knowledge of physics required. Students may not receive credit for MATH 327-0 after taking PHYSICS 330-1.

Prerequisites: MATH 228-2, or MATH 230-2, or MATH 234-0 or ES_APPM 252-2, and MATH 240-0 or GEN_ENG 205-1 or GEN_ENG 206-1; or MATH 281-3 or MATH 285-3 or MATH 290-3 or MATH 291-3.

**Formal Studies Distro Area**

**MATH 330-1 Abstract Algebra (1 Unit)**

Group theory. Students may not receive credit for both MATH 330-1 and MATH 331-1.

Prerequisite: MATH 291-1 or MATH 300-0.

**Formal Studies Distro Area**

**MATH 330-2 Abstract Algebra (1 Unit)**

Ring theory, including polynomial rings. Students may not receive credit for both MATH 330-2 and MATH 331-2.

Prerequisite: MATH 330-1 or MATH 331-1.

**Formal Studies Distro Area**

**MATH 330-3 Abstract Algebra (1 Unit)**

Field theory and Galois theory. Students may not receive credit for both MATH 330-3 and MATH 331-3.

Prerequisite: MATH 330-2 or MATH 331-2.

**Formal Studies Distro Area**

**MATH 331-1 MENU: Abstract Algebra (1 Unit)**

Group theory, including the Sylow theorems. Students may not receive credit for both MATH 331-1 and MATH 330-1.

Prerequisite: MATH 291-3; or MATH 300-0 and consent of the department.

**Formal Studies Distro Area**

**MATH 331-2 MENU: Abstract Algebra (1 Unit)**

Ring theory, including polynomial rings. Module theory, including canonical forms of operators on vector spaces. Students may not receive credit for both MATH 331-2 and MATH 330-2.

Prerequisite: MATH 331-1.

**Formal Studies Distro Area**

**MATH 331-3 MENU: Abstract Algebra (1 Unit)**

Field theory and Galois theory. Students may not receive credit for both MATH 331-3 and MATH 330-3.

Prerequisite: MATH 331-2.

**Formal Studies Distro Area**

**MATH 334-0 Linear Algebra: Second Course (1 Unit)**


Prerequisite: MATH 300-0 or MATH 291-2.

**Formal Studies Distro Area**

**MATH 336-1 Introduction to the Theory of Numbers (1 Unit)**


Prerequisite: MATH 228-1 or MATH 230-1 or MATH 281-1 or MATH 285-2 or MATH 290-2 or MATH 291-2 or ES_APPM 252-1.

**Formal Studies Distro Area**

**MATH 336-2 Introduction to the Theory of Numbers (1 Unit)**

Topics in analytic and algebraic number theory.

Prerequisite: MATH 336-1.

**Formal Studies Distro Area**

**MATH 340-0 Geometry (1 Unit)**


Prerequisite: MATH 300-0 or MATH 291-1.

**Formal Studies Distro Area**

**MATH 342-0 Introduction to Differential Geometry (1 Unit)**

Differential geometry of curves and surfaces in three-dimensional space: curves, regular surfaces, the Gauss map, and additional topics as time permits.

Prerequisites: MATH 228-2 or MATH 230-2 or MATH 234-0 or MATH 281-2 or MATH 285-3 or MATH 290-3 or MATH 291-3 or ES_APPM 252-2; and MATH 240-0 or MATH 281-3 or MATH 285-1 or MATH 290-1 or MATH 291-1 or GEN_ENG 205-1 or GEN_ENG 206-1.

**Formal Studies Distro Area**

**MATH 344-1 Introduction to Topology (1 Unit)**

Topological spaces, continuity, connectedness, compactness, countability and separation axioms.

Prerequisite: MATH 320-1 or MATH 321-1.

**Formal Studies Distro Area**

**MATH 344-2 Introduction to Topology (1 Unit)**

The fundamental group. Classification of covering spaces. Additional topics as permits.

Prerequisites: MATH 344-1, and either MATH 330-1 or MATH 331-1.
Formal Studies Distro Area

MATH 351-0 Fourier Analysis and Boundary Value Problems (1 Unit)
Fourier series with applications to partial differential equations arising in physics and engineering. Students may not receive credit for both MATH 351-0 and any of MATH 381-0, MATH 360-2, or ES_APPM 311-2.
Prerequisite: MATH 250-0 or MATH 281-3 or MATH 360-1 or GEN_ENG 206-4 or GEN_ENG 206-4.

Formal Studies Distro Area

MATH 353-0 Qualitative Theory of Differential Equations (1 Unit)
Qualitative theory of ordinary differential equations: linear systems, phase portraits, periodic solutions, stability theory, Lyapunov functions, and chaos. Students may not receive credit for both MATH 353-0 and MATH 360-2.
Prerequisite: MATH 250-0 or MATH 281-3 or MATH 360-1 or GEN_ENG 205-4 or GEN_ENG 206-4.

Formal Studies Distro Area

MATH 354-1 Chaotic Dynamical Systems (1 Unit)
Chaotic phenomena in deterministic discrete dynamical systems, primarily through iteration of functions of one variable.
Prerequisite: MATH 240-0 or MATH 281-3 or MATH 285-1 or MATH 290-1 or MATH 291-1 or GEN_ENG 205-1 or GEN_ENG 206-1.

Formal Studies Distro Area

MATH 354-2 Chaotic Dynamical Systems (1 Unit)
Iteration of functions of two or more variables, including the study of the horseshoe map, attractors, and the Henon map. Complex analytic dynamics, including the study of the Julia set and the Mandelbrot set.
Prerequisite: MATH 354-1.

Formal Studies Distro Area

MATH 360-1 MENU: Applied Analysis (1 Unit)
Linear ordinary differential equations and their applications. Students may not receive credit for both MATH 360-1 and any of MATH 250-0, MATH 281-3, GEN_ENG 205-4, GEN_ENG 206-4.
Prerequisite: MATH 290-3 or MATH 291-3.

Formal Studies Distro Area

MATH 360-2 MENU: Applied Analysis (1 Unit)
Prerequisite: MATH 360-1.

Formal Studies Distro Area

MATH 366-1 Mathematical Models in Finance (1 Unit)
Prerequisites: MATH 240-0 or MATH 281-3 or MATH 285-1 or MATH 290-1 or MATH 291-1 or GEN_ENG 205-1 or GEN_ENG 206-1; and MATH 310-1 or MATH 311-1 or MATH 314-0 or MATH 385-0 or STAT 320-1 or STAT 383-0 or IEMS 202-0 or ELEC_ENG 302-0.

Formal Studies Distro Area

MATH 368-0 Introduction to Optimization (1 Unit)
Methods and concepts of optimization theory: linear programming, duality, convexity, and Kuhn-Tucker theory.
Prerequisite: MATH 291-3; or MATH 300-0 and one of MATH 228-2, MATH 230-2, MATH 234-0, MATH 281-2, MATH 285-3, MATH 290-3, or ES_APPM 252-2.

Formal Studies Distro Area

MATH 370-0 Mathematical Logic (1 Unit)
Mathematical formulation and rigorous discussion of logical systems, particularly the propositional calculus and the functional calculi of first and second order. Well-formed formulae, formal languages, proofs, tautologies, effective procedures, deduction theorems, axiom schemata.
Prerequisite: MATH 300-0 or MATH 291-3 or consent of the instructor.

Formal Studies Distro Area

MATH 410-1 Analysis (1 Unit)

Formal Studies Distro Area

MATH 410-2 Analysis (1 Unit)

Formal Studies Distro Area

MATH 410-3 Introduction to Modern Analysis (1 Unit)
Complex analysis. Holomorphic functions, Cauchy’s theorem, power series, harmonic functions, conformal mapping, analytic continuation.

Formal Studies Distro Area

MATH 413-1 Functions of a Complex Variable (1 Unit)
Holomorphic functions: theorems of Cauchy, Morera, and Rouché residue and open mapping theorems; harmonic and entire functions; analytic continuation; conformal mapping. Schlicht functions, functions of several complex variables, Hp spaces, and complex manifolds.

Formal Studies Distro Area

MATH 414-0 Abstract Riemann Surfaces (1 Unit)

Formal Studies Distro Area

MATH 415-1 Functional Analysis (1 Unit)
Topological groups and topological vector spaces; Banach spaces, linear functionals, and operators; applications to functional equations.

Formal Studies Distro Area

MATH 415-2 Functional Analysis (1 Unit)
Topological groups and topological vector spaces; Banach spaces, linear functionals, and operators; applications to functional equations.

Formal Studies Distro Area

MATH 420-1 Partial Differential Equations (1 Unit)
Introduction to basic differential equations, with emphasis on the theory of partial differential equations.
Prerequisites: Advanced calculus and linear algebra or permission of instructor.

Formal Studies Distro Area

MATH 420-2 Partial Differential Equations (1 Unit)
Introduction to basic differential equations, with emphasis on the theory of partial differential equations.
Prerequisites: Advanced calculus and linear algebra or permission of instructor.

Formal Studies Distro Area

MATH 420-3 Partial Differential Equations (1 Unit)
Introduction to basic differential equations, with emphasis on the theory of partial differential equations.
Prerequisites: Advanced calculus and linear algebra or permission of instructor.

Formal Studies Distro Area

MATH 425-1 Partial Differential Equations (1 Unit)
Nonlinear elliptic differential equations, nonlinear hyperbolic differential equations, pseudodifferential operators, and other topics.

Formal Studies Distro Area

MATH 425-2 Partial Differential Equations II (1 Unit)
Nonlinear elliptic differential equations, nonlinear hyperbolic differential equations, pseudodifferential operators, and other topics.

**MATH 425-3 Partial Differential Equations II (1 Unit)**
Nonlinear elliptic differential equations, nonlinear hyperbolic differential equations, pseudodifferential operators, and other topics.

**MATH 428-0 Geometric Measure Theory & Applications (1 Unit)**
General measure theory, Hausdorff measure, area and co-area formulas, Sobolev functions, BV functions and set of finite perimeter, Gauss-Green theorem, differentiability and approximation, applications.

**MATH 429-0 Fourier Analysis (1 Unit)**
A short overview of classical Fourier analysis on the circle. Selected topics about Fourier analysis on the line and in Euclidean space. Prerequisite: Permission of instructor.

**MATH 430-1 Dynamical Systems (1 Unit)**
Qualitative theory of differentiable dynamical systems, emphasizing global properties such as structural stability theorems.

**MATH 430-2 Dynamical Systems (1 Unit)**
Qualitative theory of differentiable dynamical systems, emphasizing global properties such as structural stability theorems.

**MATH 430-3 Dynamical Systems (1 Unit)**
Qualitative theory of differentiable dynamical systems, emphasizing global properties such as structural stability theorems.

**MATH 435-0 Ergodic Theory (1 Unit)**
Introduction to abstract ergodic theory, focusing on the asymptotic behavior of measure preserving transformations. Topics to be covered include: measure preserving transformations and flows, convergence theorems, recurrence properties, isomorphism invariants, and applications to problems in number theory, probability, and combinatorics. Prerequisite: MATH 410-1.

**MATH 438-3 Interdisciplinary Nonlinear Dynamics (1 Unit)**
First quarter: Example-oriented survey of nonlinear dynamical systems, including chaos, combining numerical, analytical and geometrical approaches to differential chaos, combining numerical, analytical and geometrical approaches to differential equations. Second and third quarters: Interdisciplinary theoretical, computational and experimental projects involving complex systems in science and engineering directed by cross-disciplinary faculty teams.

**MATH 440-1 Geometry and Topology (1 Unit)**
Topological spaces, fundamental group, covering spaces, principal bundles, vector bundles, classifying spaces.

**MATH 440-2 Geometry and Topology (1 Unit)**
Differentiable manifolds; implicit function theorem and Sard’s theorem; smooth vector bundles, tangent vectors, tensors, vector fields and flows. Lie derivatives, Lie groups and Lie algebras. Integral manifolds, Frobenius’s theorem. Differential forms and the de Rham complex. Orientation, integration, Riemannian metrics, geodesics, exponential map. Prerequisite: MATH 440-1

**MATH 440-3 Geometry and Topology (1 Unit)**
de Rham cohomology, Mayer-Vietoris, Poincaré duality, singular homology and cohomology. Cohomology of cell complexes, simplicial cohomology, Cech cohomology. Cup product; sheaves. Prerequisite: MATH 440-2.

**MATH 444-0 Hamiltonian Dynamics and Symplectic Geometry (1 Unit)**

**MATH 445-1 Differential Geometry (1 Unit)**
Riemannian geometry: connections, geodesics, completeness, Jacobi fields, exponential map, constant curvature.

**MATH 445-2 Differential Geometry (1 Unit)**
Hodge theory: connections, curvature, de Rham complex, Hodge decomposition, Kahler manifolds, Chern-Weil theorem.

**MATH 445-3 Differential Geometry (1 Unit)**
Further topics: connections and curvature on principal and associated bundles; symplectic geometry, classical mechanics and geometric quantization; Dirac operators and index theorems.

**MATH 450-1 Probability Theory & Stochastic Analysis (1 Unit)**

**MATH 450-2 Probability Theory and Stochastic Analysis (1 Unit)**
Random walk, Markov chains, martingales, and stochastic processes. Definition and properties of standard Brownian motion.

**MATH 450-3 Probability Theory and Stochastic Analysis (1 Unit)**
Stochastic Integration and stochastic differential calculus, with applications to diffusion processes.

**MATH 460-1 Algebraic Topology (1 Unit)**
Fundamental group and covering spaces.

**MATH 460-2 Algebraic Topology (1 Unit)**
Simplicial, singular, and cellular (co-)homology, universal coefficient and Kuenneth theorems. Prerequisite: MATH 460-1.

**MATH 460-3 Algebraic Topology (1 Unit)**
Cohomology rings and Poincaré duality, Thom Isomorphism and characteristic classes. Prerequisite: MATH 460-2.

**MATH 465-1 Algebraic Topology II (1 Unit)**
Cohomology theories and operations, homotopy and obstruction theory, and CW complexes; spectral sequences. Multiple registrations allowed.

**MATH 465-2 Algebraic Topology II (1 Unit)**
Cohomology theories and operations, homotopy and obstruction theory, and CW complexes; spectral sequences. Multiple registrations allowed.

**MATH 465-3 Algebraic Topology II (1 Unit)**
Cohomology theories and operations, homotopy and obstruction theory, and CW complexes; spectral sequences. Multiple registrations allowed.

**MATH 468-0 Homological Algebra (1 Unit)**
Exact sequences, Ext and Tor, and homological dimensions.

**MATH 470-1 Algebra (1 Unit)**

**MATH 470-2 Algebra (1 Unit)**

**MATH 470-3 Algebra (1 Unit)**

MATH 477-0 Commutative Algebra (1 Unit)
Prerequisites: MATH 470-1, MATH 470-2, MATH 470-3 or equivalent.

MATH 478-0 Representation Theory (1 Unit)
Topics in the representation theory and cohomology of finite and infinite groups, including compact and non-compact Lie groups.

MATH 482-1 Algebraic Number Theory (1 Unit)
The theory of global and local fields; various special topics. 2. Abelian Galois extensions of algebraic number fields (class field theory). Complex multiplication, other examples, and relations with geometry.

MATH 482-2 Algebraic Number Theory (1 Unit)
Abelian Galois extensions of algebraic number fields (class field theory). Complex multiplication, other examples, and relations with geometry.

MATH 483-1 Algebraic Geometry (1 Unit)
Introduction to classical and scheme theoretic methods of algebraic geometry. Algebraic vector bundles, sheaf cohomology, the Riemann-Roch theorem for curves, and intersection theory.

MATH 483-2 Algebraic Geometry (1 Unit)
Introduction to classical and scheme theoretic methods of algebraic geometry. Algebraic vector bundles, sheaf cohomology, the Riemann-Roch theorem for curves, and intersection theory.

MATH 483-3 Algebraic Geometry (1 Unit)
Introduction to classical and scheme theoretic methods of algebraic geometry. Algebraic vector bundles, sheaf cohomology, the Riemann-Roch theorem for curves, and intersection theory.

MATH 484-0 Lie Theory (1 Unit)
Topics in the theory of Lie algebras and Lie groups including classification.

MATH 485-1 Modular Forms (1 Unit)
Introduction to the theory of modular forms. Congruence subgroups of SL (2, Z), the definitions of modular functions and modular forms, Fourier expansions, Hecke operators, theta functions, modular curves.

MATH 486-1 Algebraic K-Theory (1 Unit)
Classical algebraic K-theory. Functors K0 and K1; origins in and relations with topology; congruence subgroup problem; techniques of computation: exact sequences, localization, resolution, and devissage; polynomial and related extensions; higher K-theories: Karoubi-Villamayor, Quillen.

MATH 486-2 Algebraic K-Theory (1 Unit)
Classical algebraic K-theory. Functors K0 and K1; origins in and relations with topology; congruence subgroup problem; techniques of computation: exact sequences, localization, resolution, and devissage; polynomial and related extensions; higher K-theories: Karoubi-Villamayor, Quillen.

MATH 486-3 Algebraic K-Theory (1 Unit)
Classical algebraic K-theory. Functors K0 and K1; origins in and relations with topology; congruence subgroup problem; techniques of computation: exact sequences, localization, resolution, and devissage; polynomial and related extensions; higher K-theories: Karoubi-Villamayor, Quillen.

MATH 495-0 Statistical Phenomena in the Theory of Networks (1 Unit)
This interdisciplinary course combines graph theory and probability theory to develop a rigorous foundation for the study of network-related problems.

MATH 499-0 Independent Study (1 Unit)
Permission of instructor and department required. May be repeated for credit.

MATH 511-1 Topics in Analysis (1 Unit)
Topics in Analysis and Probability Theory.

MATH 511-2 Topics in Analysis (1 Unit)
Topics in Analysis and Probability Theory.

MATH 511-3 Topics in Analysis (1 Unit)
Topics in Analysis and Probability Theory.

MATH 512-1 Topics in Partial Differential Equations (1 Unit)
Topics in Partial Differential Equations.

MATH 512-2 Topics in Partial Differential Equations (1 Unit)
Topics in Partial Differential Equations.

MATH 512-3 Topics in Partial Differential Equations (1 Unit)
Topics in Partial Differential Equations.

MATH 513-1 Topics in Dynamical Systems (1 Unit)
Topics in Partial Differential Equations.

MATH 513-2 Topics in Dynamical Systems (1 Unit)
Topics in Partial Differential Equations.

MATH 513-3 Topics in Dynamical Systems (1 Unit)
Topics in Partial Differential Equations.

MATH 514-1 Topics in Geometry (1 Unit)
Topics in Geometry.

MATH 514-2 Topics in Geometry (1 Unit)
Topics in Geometry.

MATH 514-3 Topics in Geometry (1 Unit)
Topics in Geometry.

MATH 515-1 Topics in Geometry and Topology (1 Unit)
This is a working seminar for students with interests in geometry, topology, and related fields. Its primary aim is to introduce students to research subjects of current interest to faculty members in these areas.

MATH 515-2 Topics in Geometry and Topology (1 Unit)
This is a working seminar for students with interests in geometry, topology, and related fields. Its primary aim is to introduce students to research subjects of current interest to faculty members in these areas.

MATH 515-3 Topics in Geometry and Topology (1 Unit)
This is a working seminar for students with interests in geometry, topology, and related fields. Its primary aim is to introduce students to research subjects of current interest to faculty members in these areas.

MATH 516-1 Topics in Topology (1 Unit)
Topics in Topology.

MATH 517-1 Topics in Algebra (1 Unit)
Topics in Algebra.

MATH 517-2 Topics in Algebra (1 Unit)
Topics in Algebra.

MATH 517-3 Topics in Algebra (1 Unit)
Topics in Algebra.

MATH 518-1 Topics in Number Theory (1 Unit)
Topics in Number Theory.

MATH 518-2 Topics in Number Theory (1 Unit)
Topics in Number Theory.

MATH 518-3 Topics in Number Theory (1 Unit)
Topics in Number Theory.

MATH 519-0 Responsible Conduct of Research Training (0 Unit)
Responsible Conduct of Research Training.

MATH 520-1 Topics in Mathematical Physics (1 Unit)
Topics in Mathematical Physics.

MATH 521-1 Topics in Representation Theory (1 Unit)
Topics in Representation Theory.

MATH 521-2 Topics in Representation Theory (1 Unit)
Topics in Representation Theory.

MATH 521-3 Topics in Representation Theory (1 Unit)
Topics in Representation Theory.

MATH 580-0 Seminar in College Teaching (0 Unit)
A weekly two-hour seminar introducing the technique, philosophy, and practice of teaching undergraduate mathematics. Student presentations are critiqued by fellow students, as well as a senior faculty member.

MATH 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS - Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

**Mechanical Engineering (MECH_ENG)**

MECH_ENG 314-0 Machine Dynamics (1 Unit)
Three-dimensional kinematics: rotation axes and mechanism analysis, rotation matrices and Euler's angles for rigid bodies. Three-dimensional kinematics: dynamics of particles, central force problems, dynamics of rigid bodies, rotational inertia matrices and principal axes, dynamics of mechanisms, the gyroscope and other torque-free problems. Prerequisite: MECH_ENG 202-0.

MECH_ENG 316-0 Mechanical Systems Design (1 Unit)
Design of mechanical systems such as cams, multi-bar linkages, and precision machines. Design principles and best practices. Case studies and team-based projects. Prerequisite: MECH_ENG 315-0.

MECH_ENG 317-0 Molecular Modeling and the Interface to Micromechanics (1 Unit)
Introduction to modern computational methods for calculating thermodynamic, transport, and structural properties of materials. Computational chemistry, molecular simulation, and mesoscopic methods, with emphasis on tribology applications.

MECH_ENG 318-0 Multiscale Simulations (1 Unit)
Introduction to multiscale modeling and simulation methods for studying material interactions in micro and nanomechanical systems, as well as in electronic packaging. Hands-on exercises using equipment to characterize nanoscale properties and parallel computer codes.

MECH_ENG 320-0 Micro- and Nanomechanical Properties of Surfaces (1 Unit)
Micro and nanomechanical interactions between surfaces, fractal nature of surfaces, interfacial forces, principles of micromechanics, characterization of surfaces using atomic force microscopy, optical interferometry, and nanoindentation.

MECH_ENG 322-0 Thermodynamics & Statistical Mechanics - II (1 Unit)
Classical and statistical thermodynamics. Prerequisite: MECH_ENG 222-0

MECH_ENG 327-0 Finite Elements for Stress Analysis (1 Unit)
Development of finite elements from variational principles and application to static stress analysis. Introduction to techniques for transient and generalized field problems. Computer implementation of finite element techniques. Taught with CIV_ENV 327-0; may not receive credit for both courses.

MECH_ENG 333-0 Introduction to Mechatronics (1 Unit)
Introduction to microprocessor-controlled electromechanical systems. Interfacing sensors and actuators to computers, electrical and mechanical prototyping, dissection of a commercial product. Final team project. Prerequisite: MECH_ENG 233-0, ELEC_ENG 221-0, or consent of instructor.

MECH_ENG 340-1 Comp Integrating Manufacturing: Manufacturing Processes (1 Unit)
Use of computers to improve productivity and reduce costs in the manufacture of discrete parts and assemblies. Manufacturing processes: Analysis and evaluation of process usage in the contemporary manufacturing environment. Prerequisite: MECH_ENG 240-0 or consent of instructor.

MECH_ENG 340-2 Computer Integrating Manufacturing: CAD/CAM (1 Unit)
Use of computers to improve productivity and reduce costs in the manufacture of discrete parts and assemblies. CAD/ CAM: Geometric modeling, dimensioning systems, tolerances, design for manufacture, programming of machine tools. Prerequisite: MECH_ENG 340-1 or consent of instructor.

MECH_ENG 340-3 Computer Integrating Manuf: Automation (1 Unit)
Use of computers to improve productivity and reduce costs in the manufacture of discrete parts and assemblies. Manufacturing automation: sensors, actuators, and computers for automation; principles of computer control; programmable logic controllers; robotic devices; assembly automation. Prerequisite: MECH_ENG 340-2 or consent of instructor.

MECH_ENG 341-0 Computational Methods for Engineering Design (1 Unit)
Introduction to a wide range of computational techniques for engineering design. Modeling, simulation, optimization, design software, examples, and projects with emphasis on computational techniques for design and manufacturing related applications. Prerequisite: senior standing or consent of instructor.

MECH_ENG 346-0 Introduction to Tribology (1 Unit)

MECH_ENG 359-0 Reliability Engineering (1 Unit)

MECH_ENG 362-0 Stress Analysis (1 Unit)

MECH_ENG 363-0 Mechanical Vibrations (1 Unit)
Analysis of vibrations in single and multi-degree of freedom systems. Free and forced vibrations with various types of damping. Response to steady-state and transient excitations. Prerequisite: MECH_ENG 202-0

MECH_ENG 366-0 Finite Elements for Design & Optimization (1 Unit)
Numerical methods for interaction and optimal CAD. Fully stressed design; design sensitivity analysis and descent methods; optimality criteria to automated design. 
Prerequisites: senior standing; MECH_ENG 327-0 or consent of instructor.

MECH_ENG 367-0 Quantitative Methods in Life Cycle Analysis (1 Unit)
Lifecycle analysis (LCA) framework for environmental assessment of technology systems, focusing on modeling methods for systems mass and energy flows, process and input-output-based systems inventories, environmental impact analysis, and methods for robust engineering decisions. MECH_ENG 367-0 is taught with CHEM_ENG 367-0; may not receive credit for both courses.

MECH_ENG 371-0 Combustion Engines (1 Unit)
Theoretical and actual cycles, combustion, detonation, carburetion, fuels, performance characteristics, and fuel-cell power.

MECH_ENG 373-0 Engineering Fluid Mechanics (1 Unit)
Laminar and turbulent duct flows. Boundary layers and potential flows. Lift and drag forces. Thermodynamics and mechanics of compressible flow. Nozzle flows and choking. Wave motion and shock waves. Applications to fluid machinery. Prerequisite: MECH_ENG 241-0.

MECH_ENG 377-0 Heat Transfer I (1 Unit)

MECH_ENG 380-0 Thermal Energy Systems Design (1 Unit)
Applications of the principles of energy engineering analysis to the design of thermal systems. Consideration of such systems as air conditioning, oil piping, refrigeration, fluid distribution, and pneumatic control. Projects will be tailored to the class. Solution of open-ended design problems including introduction to EES (Engineering Equation Solver) software that has built-in thermophysical properties. Prerequisite: Basic Thermodynamics or equivalent.

MECH_ENG 381-0 Introduction to Micro-electro-mechanical Systems (1 Unit)
Introduction to MEMS devices, with an emphasis on their manufacturing and mechanical behavior. Materials properties, microfabrication technology, mechanical behavior of microstructures, design, and packaging. Case studies on sensors, wireless communications, fluidic systems, microengines, and biological devices. Prerequisite: CIV_ENV 216-0 or consent of instructor.

MECH_ENG 382-0 Experiments in Micro- and Nano Science and Engineering (1 Unit)
Interdisciplinary topics spanning the physical and biological sciences and engineering. Seven integrated labs in which students acquire hands-on experience in various aspects of micro-and nanoscience and engineering: cleanroom microfabrication, flow visualization in micro-channels, nanomechanics, AFM and dippen nanolithography, multiphysics computational tools, and experimental techniques to evaluate micro-and nanoscale devices. Prerequisite: MECH_ENG 381-0 or consent of instructor.

MECH_ENG 385-0 Nanotechnology (1 Unit)
Manipulation of matter at the nanometer-length scale to produce useful devices and materials. Scientific and engineering properties of nanoscale systems. Emphasis on development of new techniques.

MECH_ENG 389-0 Molecular Machines in Biology (1 Unit)
Introduction to engineering principles that govern cellular activities at the molecular level. Emphasis on the dynamics and kinematics of proteins, especially those that are locomotory or force generating. Lectures, team projects, and presentations. Prerequisite: MATH 228-1 or consent of instructor.

MECH_ENG 390-0 Intro to Dynamic Systems (1 Unit)
Modeling the dynamic behavior of physical systems. Concepts of causality, dependent and independent storages, and state. Introduction to bond graphs. Generation of state equations; analytical and computer simulation of system behavior. Application to problems of engineering interest. Prerequisites: MECH_ENG 202-0, MECH_ENG 241-0; CIV_ENV 216-0; GEN_ENG 205-4.

MECH_ENG 395-0 Special Topics in Mechanical Engineering (1 Unit)
Topics suggested by students or faculty members and approved by the department.

MECH_ENG 413-0 Experimental Solid Mechanics (1 Unit)
Brief review of applied elasticity and fracture mechanics. Review of experimental methods for measuring mechanical behavior of solids, including deformation and fracture, fracture toughness and dynamic response at high strain rates. Methods discussed include strain gages, photoelasticity, birefringent coatings, moiré, digital image correlation, and fiber optic methods. CIV_ENV 413-0 and MECH_ENG 413-0 are co-listed.

MECH_ENG 414-1 Mechanics of Composite Materials 1 (1 Unit)
Introduction to basic concepts: fabrication of composite materials, micromechanics, macro-mechanics of unidirectional lamina, failure theories, mechanics of multidirectional laminate, lamination theory, hydrothermal effects, inter-laminar stresses, stress concentrations, structural design and optimization, and nondestructive evaluation. CIV_ENV 414-1 and MECH_ENG 414-1 are co-listed.

MECH_ENG 414-2 Mechanics of Composite Materials II (1 Unit)
Introduction to basic concepts: fabrication of composite materials, micromechanics, macro-mechanics of unidirectional lamina, failure theories, mechanics of multidirectional laminate, lamination theory, hydrothermal effects, inter-laminar stresses, stress concentrations, structural design and optimization, and nondestructive evaluation. CIV_ENV 414-2 and MECH_ENG 414-2 are co-listed.

MECH_ENG 416-0 Computational Nanodynamics (1 Unit)
The objective of this course is to learn how to use theoretical and computational modeling tools to simulate dynamic solid mechanics phenomena at small scales.

MECH_ENG 417-0 Multi-scale Modeling and Simulation in Solid Mechanics (1 Unit)
Introduction to modern computational methods such as molecular dynamics and continuum mechanics. Applications will be nanostructure and polymer composites.

MECH_ENG 418-0 Multi-Scale Modeling and Simulation in Fluid Mechanics (1 Unit)
Introduction to modern computational methods such as molecular dynamics and continuum mechanics. Applications will be Biological and bioinspired materials: Biopolymer, Protein, DNA, Lipids.

MECH_ENG 420-0 Micro- and Nanoscale Fluid Dynamics (1 Unit)
MECH_ENG 427-0 Viscous Fluid Dynamics (1 Unit)

The molecular basis of fluid mechanics, the Knudsen number and non-slip boundary conditions, Stokes flow, electrokinetic flows: Debye layers, zeta-potentials, Helmholtz-Smoluchowski slip boundary conditions.

MECH_ENG 421-0 Design and Analysis of Microfluidic Systems (1 Unit)
Introduction to Lab-on-chip, mTAS, microreactors & microarrays, fluid mechanics of microfluidic devices, multi-physics phenomena e.g. electrohydrodynamics, magnetohydrodynamics, developing reduced order models, design and analysis.

MECH_ENG 422-0 Statistical Mechanics for Applications (1 Unit)
Modeling of systems with emergent behavior. The course has two components: (1) basic and intermediate statistical mechanics, and (2) application of the course methods to a case study, chosen from topics to include: dynamics of polymers, including proteins and nucleic acids; molecular machines; pattern formation, including turbulence and phyllotaxis; geomorphology; conflict, including warfare, terrorism and revolution; and economics.

MECH_ENG 423-0 Intro to Computational Fluid Dynamics (1 Unit)
Discretization methods, solution of Navier-Stokes equations, algorithms for fluid flow problems (pressure-based algorithms, fractional time-stepping schemes, etc.), three-dimensional, steady, unsteady flows.

MECH_ENG 424-0 Advanced Topics in Computational Fluid Dynamics (1 Unit)
Moving mesh techniques, immersed boundary techniques, numerical methods for sub-micron/nanoscale fluid dynamics-stochastic equations, molecular dynamics for liquids, Monte Carlo simulations, hybrid simulations.

MECH_ENG 424-1 Computational Fluid Dynamics I (1 Unit)

MECH_ENG 424-2 Computational Fluid Dynamics II (1 Unit)

MECH_ENG 425-0 Fundamentals of Fluid Dynamics (1 Unit)
Basis for advanced courses in fluid dynamics. Stress, flow kinematics, rate of strain, material derivatives, and general balance equations. Navier-Stokes equations and exact solutions.

MECH_ENG 425-2 Fundamentals of Fluid Dynamics II (1 Unit)

MECH_ENG 426-1 Advanced Finite Element Methods I (1 Unit)
Discretization methods, weak and strong forms, Newton methods for constrained and unconstrained problems, explicit methods, continuation methods.
Prerequisite: MECH_ENG 327-0 or equivalent.

MECH_ENG 426-2 Advanced Finite Element Methods II (1 Unit)
Alternative mesh descriptions, Langrangian, Eulerian, and arbitrary Langrangian Eulerian, meshless methods and particle methods, continuum based shell formations, contract-impact.
Prerequisite: MECH_ENG 426-1.

MECH_ENG 427-0 Viscous Fluid Dynamics (1 Unit)

D'Alembert's paradox and the role of viscosity, vorticity diffusion, boundary layers, separation, viscous dissipation of energy, introduction to turbulence, Stokes flow.

MECH_ENG 428-0 Compressible and Inviscid Fluid Dynamics (1 Unit)
Fuler equations and the evolution of vorticity, 2D incompressible flows, potential flows, shock waves, acoustics.

MECH_ENG 429-0 Turbulent Flows (1 Unit)
Kinematics of turbulent flow fields: dynamical processes. Application of models to isotropic and shear flow turbulence; turbulent diffusion. Effects of compressibility and buoyancy on turbulent flows.

MECH_ENG 432-0 The Calculus of Variations and Its Applications (1 Unit)
Extremizing multivariate functions, the functional and its variation, Euler-Lagrange equations, isoperimetric problems, applications to optics, mechanics, potential theory, fluid mechanics, wave theory and elasticity.

MECH_ENG 433-0 Advanced Mechatronics (1 Unit)
Hands-on laboratory class on design and control of electromechanical systems. Real time operating systems, analog and digital electronics, sensors and actuators. Lectures, labs, and projects.

MECH_ENG 434-0 Random Data and Spectral Analysis (1 Unit)
Introduction to analysis of random data: stationarity, ergodicity, probability density function and related statistics, spectral density function, autocorrelation, and crossing analysis. Applying spectral analysis: fast Fourier transform, aliasing, zero-padding, and excitation-response characteristics. Nonstationary data and spectral analysis.

MECH_ENG 438-3 Interdisciplinary Nonlinear Dynamics (1 Unit)
Interdisciplinary theoretical, computational and experimental projects involving complex systems in science and engineering directed by cross-disciplinary faculty teams.

MECH_ENG 439-0 Computer Control in Manufacturing (1 Unit)
Digital control theory, design methodology, and techniques for controller implementation of digital computers. Discrete system modeling, system identification, and adaptive control methods. Single and multiaxis motion-generation algorithms. Multiple objective control systems for machinery guidance, manufacturing process, and precision control.
Prerequisites: MECH_ENG 340-1, MECH_ENG 340-2, or permission of instructor.

MECH_ENG 440-1 Tech In Mfg Env (1 Unit)
An introduction to quantitative principles in modern manufacturing technology. Techniques for understanding limitations on precision, repeatability, and rate imposed by physics; enhancement of quality and productivity by automatic control; process monitoring; information management; and the effects of these factors on success in the marketplace.
Prerequisite: Enrollment in MMM program or by petition to the department.

MECH_ENG 441-0 Engineering Optimization for Product Design and Manufacturing (1 Unit)
Introduction to optimization theory and numerical techniques. Formulations, algorithms, computer implementation, examples/projects with emphasis in numerical and emerging techniques for design and manufacturing related applications.
Prerequisite: Graduate standing, senior undergraduate, or permission of instructor.

MECH_ENG 442-0 Metal Forming (1 Unit)
Metal forming processes: drawing, extrusion, rolling, forging, and sheet metal forming. Process analysis and design: force estimation, friction and
redundant work effects, temperatures generated, defects, and process and equipment limitations.

**MECH_ENG 443-0 Metal Cutting (1 Unit)**


**MECH_ENG 445-0 Micromanufacturing (1 Unit)**

**MECH_ENG 446-0 Advanced Tribology (1 Unit)**

Generalized Reynolds equation; thermal, turbulent, inertia, fluid compressibility, and surface roughness effects in sliding bearings; fatigue, scuffing, and wear in elastohydrodynamic contact; plastohydrodynamic lubrication in metal rolling, extrusion, and forging.

**MECH_ENG 448-0 Flexible Automation and Robotics (1 Unit)**

Introduction to state-of-the-art research in robotics. Robot geometries and kinematics; robot programming languages; dynamics and control; motion planning; machine vision; parts-feeders and jigs; assembly planning; sensors and actuators; scheduling; mobile robots.

**MECH_ENG 449-0 Robotic Manipulation (1 Unit)**

Mechanics of robotic manipulation, computer representations and algorithms for manipulation planning, applications to industrial automation, parts feeding, grasping, fixtureing, assembly.

**MECH_ENG 450-0 Geometry in Robotics (1 Unit)**

Application of tools from differential geometry and Lie groups to problems in dynamics, controllability, and motion planning for mechanical systems, particularly with non-Euclidean configuration spaces.

**MECH_ENG 451-0 Micromachining (1 Unit)**

Fundamental fabrication issues for microscale components used in MEMS/Nanotechnology. Understand and designing microfabrication processes based on photolithography and deposition/etching steps.

**MECH_ENG 453-0 Micro Systems Design (1 Unit)**

Theory and tools for analyzing and designing microsystems used in MEMS/Nanotechnology. Includes device physics and analysis, design techniques, and computer-aided design tools for micro systems technology.

**MECH_ENG 454-0 Numerical Methods in Optimal Control of Nonlinear Systems (1 Unit)**

**MECH_ENG 456-0 Mechanics of Advanced Materials (1 Unit)**

Microscale mechanisms and their relation to macroscopic behavior and mathematical constitutive modeling for advanced material systems. Emphasis on polymer viscoelasticity, shape memory materials, other material systems.

**MECH_ENG 465-0 Wave Propagation in Elastic Solids (1 Unit)**

Plane waves, longitudinal and transverse waves, harmonic waves and pulses, energy considerations, reflection, and transmission mode conversion, Fourier superposition, surface waves, basic singular solutions, integral representations, scattering and diffraction problems, and waves in layers and rods. Prerequisites: MECH_ENG 363-0, or MECH_ENG 390-0 and ES_APPM 311-1, ES_APPM 311-2, or equivalents.

**MECH_ENG 466-0 Inelastic Constitutive Relations for Solids (1 Unit)**

Introduction to the formulation and implementation of inelastic constitutive relations for solids. Viscoelasticity, rate-independent plasticity, viscoplasticity. State variable descriptions and thermodynamic restrictions. Prerequisites: CIV_ENV 317-0, CIV_ENV 415-0, MECH_ENG 362-0 or equivalent.

**MECH_ENG 467-0 Industrial Energy Management and Utilization (1 Unit)**

As time permits, in this course the students will learn about historical energy usage; energy conservation vs. energy management; elements of an energy audit; data normalization of energy consumption using product-mix data or degree days etc.; utility rate structures & deregulation; energy economics; energy conservation opportunities in thermal-fluid Systems; combustion systems; steam & condensate Systems; energy recovery systems; industrial insulation; and electrical energy conservation.

Prerequisite: Thermodynamics (MECH_ENG 222-0 or equivalent) or Consent of Instructor or Graduate Standing

**MECH_ENG 469-0 Machine Learning and Artificial Intelligence for Robotics (1 Unit)**

A coverage of artificial intelligence, machine learning and statistical estimation topics that are especially relevant for robot operation and robotics research. The focus is on robotics-relevant aspects of ML and AI that are not covered in depth in COMP_SCI 348-0 or COMP_SCI 349-0. Course evaluation will be largely project based. Some programming experience (MatLab is okay). Undergraduate student enrollment by permission of instructor only.

Prerequisite: Graduate-level standing or permission of instructor.

**MECH_ENG 470-0 High Performance Computing for Multiphysics Applications (1 Unit)**

Theory, numerical methods, code development, and practical considerations for large-scale simulation of complex engineering systems, particularly those that bring together multiple physical phenomena. Topics include parallel programming and performance, iterative solvers and preconditioning, solution algorithms, and applications.

**MECH_ENG 478-1 Combustion (1 Unit)**

Equations of motion for reacting flows, theory of laminar flames, flame structure and stability, combustion of liquid and solid fuels, ignition, extinction, and flammability limits.

**MECH_ENG 489-0 Selected Topics in Cellular Level Transport (1 Unit)**

Current topics dealing with intracellular and extracellular transport, including ion channels, molecular motors, the mechanics of DNA, microtubules, flagella dynamics, locomotion, collective behavior, infection, signaling.

Prerequisite: Permission of instructor.

**MECH_ENG 492-0 Robust Control Theory (1 Unit)**


**MECH_ENG 495-0 Selected Topics in Mechanical Engg (1 Unit)**

Topics selected from work of current interest in mechanical engineering.

**MECH_ENG 497-0 Special Topics in Mechanical Engineering (0.5 Unit)**

In-depth review of how a number of new computer-aided engineering technologies are used to give the modern manufacturing enterprise strategic advantage.

**MECH_ENG 499-0 Projects (1-3 Units)**

Special projects carried out under staff direction. Permission of instructor and department required. May be repeated for credit.

**MECH_ENG 512-0 Seminar (0 Unit)**
MECH_ENG 513-0 Professional Essentials (0 Unit)
Seminar course covering techniques for teaching and technical presentation skills, organizational issues associated with teaching and presentations. Active teaching duties will be assigned during the course and performance feedback provided.

MECH_ENG 519-0 Responsible Conduct of Research Training (0 Unit)
MECH_ENG 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit. - SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Media, Technology & Society (MTS)

MTS 499-0 Independent Studies (1 Unit)
Independent Studies.

MTS 501-0 Introduction to Grad Research in MTS (1 Unit)
Acquaints students with the research practices and professional norms typical of this field of study. It offers survey of research methods in common use including textual analysis, qualitative and quantitative methods.

MTS 502-1 Intellectual Issues in Media, Technology, and Society (1 Unit)
Explores the issues and ideas that have been influential in understanding media and mass culture including; research traditions; concepts of audience, spectatorship, and influence; and relations between science, technology and media culture.

MTS 503-0 The Practice of Scholarship (1 Unit)
This course is a study of basic protocols of scholarly research and writing in the social sciences. Course work is focused on bringing a research project to the point at which an article is ready (or nearly so) for submission to a conference or a publication.

MTS 519-0 Responsible Conduct of Research (0 Unit)
The course addresses the responsible conduct of research and its impact on individual and social behavior. Topics may include conflict of interest, mentor/mentee responsibilities and relationships, collaborative research including collaborations with industry, peer review, data acquisition and management, research misconduct, privacy, the researcher as a responsible member of society, and other current research conduct issues in this field.

MTS 525-0 Special Topics Research Seminar (1 Unit)
Content varies. May be repeated for credit with change of topic.

MTS 590-0 Research (1-3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation.

Medical Humanities and Bioethics (MHB)

MHB 401-0 Foundations of Bioethics (1 Unit)
This course will explore major theories and key cases in contemporary bioethics. Participants will learn the history and the application of principlism, casuistry, care ethics, virtue ethics, narrative ethics, pragmatism, and communitarianism. The central issues in bioethics will be examined through key historical cases.

MHB 402-0 Medicine & Law (1 Unit)
Using judicial opinions as our primary text and constitutional law as our primary lens, this course analyzes how the U.S. legal system mediates conflicts between individuals and the State, parents and children, and doctors and patients. Topics covered include reproductive medicine (contraception, abortion, and assisted reproduction), termination of life support and other treatments by patients and surrogates, and physician assisted suicide. In addition to increasing substantive legal knowledge, the course aims to help students to interpret and engage with the medico-legal texts and arguments they will encounter in the future by improving their rhetorical skills and legal literacy.

MHB 403-0 The History of Medicine and Bioethics (1 Unit)
The history of medicine in the United States is a large subject, and in this seminar we will touch on many, but by no means all, of what can be considered as part of this history. In addition to covering an abbreviated history of medicine in the US with the goals of helping you place current topics in medicine within a historical frame (and appreciating this frame as a useful one), this course will also give you a chance to think like a historian and provide a basic introduction to historical methodology.

MHB 404-0 Literature, Medicine, and Bioethics (1 Unit)
This course surveys the uses of literary texts and theories in understanding the workings of health care, illness experience, and bioethics. The first five weeks focus on narratology and close reading as methods for understanding texts relevant to medicine and illness; the second on how narrative works in bioethics, from clinical ethics to speculative fiction to the design of health policy.

MHB 405-0 Social Science and Medicine (1 Unit)
This course will introduce students to key classic and contemporary scholarship in the social science of medicine to explore how empirical research can inform and enrich our understanding of moral issues in medicine. Organized around a series of core topics in bioethics (e.g. death and dying, reproductive technologies, organ transplantation, and disability), the course examines a range of theoretical frameworks and methodological strategies from the social sciences, with a particular emphasis on ethnographic and cross-cultural approaches. Students will learn how to interpret and assess social scientific research, as well as how to bring a social scientific perspective to bear on problems in medicine.

MHB 406-0 The Practice of Bioethics (1 Unit)
This capstone course takes students from theory to practice, providing an introduction to ways they might put their MHB knowledge into action as they develop careers in various clinical and social contexts. One-third of the course is devoted to the practice of clinical ethics consultation and the work of institutional ethics committees. Other topics covered include writing and publishing academic articles, delivering compelling conference presentations, developing excellent teaching skills, conducting and regulating research, and offering expert opinion to public debate through the media.

MHB 410-1 Special Topics in Medical Humanities and Bioethics (0.33 Unit)
This course is a year-long weekly series of one-hour lunchtime lectures chosen to illustrate the breadth and depth of topics in bioethics and the medical humanities. These lectures are delivered by faculty members and invited guests, on topics in which they specialize.

MHB 410-2 Special Topics in Medical Humanities and Bioethics (0.34 Unit)
This course is a year-long weekly series of one-hour lunchtime lectures chosen to illustrate the breadth and depth of topics in bioethics and the medical humanities. These lectures are delivered by faculty members and invited guests, on topics in which they specialize.

MHB 410-3 Special Topics in Medical Humanities and Bioethics (0.33 Unit)
This course is a year-long weekly series of one-hour lunchtime lectures chosen to illustrate the breadth and depth of topics in bioethics and the medical humanities. These lectures are delivered by faculty members and invited guests, on topics in which they specialize.

**MEN 412-3 MENA Graduate Colloquium (1 Unit)**
This is a unit of independent study on a topic or topics within bioethics and/or the medical humanities. Students will study independently or in groups and will meet periodically with a program faculty member ("tutor"). Specific details of course content and meeting schedule are designed collaboratively between student(s) and tutor as appropriate to the chosen topic.

**Medical Scientist Training (MSTP)**
**MSTP 401-0 MSTP Colleges Curriculum (0 Unit)**
The curriculum consists of several learning forums, including entire program plenaries, faculty- and student-led journal clubs, grant writing courses, skills development sessions, social outings and student TED talks and includes activities relevant to all stages of MSTP training.

**MSTP 402-0 MSTP Grand Rounds (0 Unit)**
Seminar course for students in the all phases of the combined MD/PhD Program. Discussion of clinical cases is followed by discussion of relevant basic science research issues.

**MSTP 590-0 Research (1-3 Units)**

**Medieval Studies (MDVL_ST)**
**MDVL_ST 420-0 Medieval Doctoral Colloquium (0 Unit)**
**MDVL_ST 430-0 Paleography (1 Unit)**

**Middle East and North African Studies (MENA)**
**MENA 410-0 Pro-Seminar in Middle East and North African Studies (1 Unit)**
Introduces students to key scholarly literature in the field, drawn from a variety of disciplines.

**MENA 411-0 Approaches and Perspectives in MENA Studies (1 Unit)**
Surveys differing disciplinary approaches to the study of the Middle East and North Africa, often organized around a theme.

**MENA 412-1 MENA Graduate Colloquium (0 Unit)**
The MENA Colloquium is designed to encourage dialogue between professors and students who share interests in Middle East and North African Studies at Northwestern University. Each student will precirculate a paper of 15-20 pages a week before his or her session. At the meeting, the student will speak for 20-25 minutes followed by a formal response (about 10 minutes) from a member of Northwestern's MENA faculty. Substantial time will be devoted to questions and discussion.

**MENA 412-2 MENA Graduate Colloquium (0 Unit)**
The MENA Colloquium is designed to encourage dialogue between professors and students who share interests in Middle East and North African Studies at Northwestern University. Each student will precirculate a paper of 15-20 pages a week before his or her session. At the meeting, the student will speak for 20-25 minutes followed by a formal response (about 10 minutes) from a member of Northwestern's MENA faculty. Substantial time will be devoted to questions and discussion.

**MENA 412-3 MENA Graduate Colloquium (1 Unit)**

The MENA Colloquium is designed to encourage dialogue between professors and students who share interests in Middle East and North African Studies at Northwestern University. Each student will precirculate a paper of 15-20 pages a week before his or her session. At the meeting, the student will speak for 20-25 minutes followed by a formal response (about 10 minutes) from a member of Northwestern's MENA faculty. Substantial time will be devoted to questions and discussion.

**MENA 415-0 MENA Graduate Colloquium Advanced (0 Unit)**
Substantial time will be devoted to questions and discussion.

**MS in Family Therapy (MS_FT)**
**MS_FT 400-0 Professional Identity Seminar (0 Unit)**
The Professional Identity seminar is divided into two separate sections. The clinical section focuses on issues relevant to clinicians including resume writing, the job search and licensing procedures. It also describes the capstone project in depth. The clinical/research section is geared towards those interested in pursuing a Ph.D. The focus is on finding the right Ph.D. program, how to make yourself competitive for Ph.D. work and writing an application. For second year students, the focus is also on writing a Master's thesis.

**MS_FT 401-0 Basic Concepts of Systems Therapy (1 Unit)**
This course is an introduction to the central theoretical underpinnings of systemic family therapy, providing a basic framework for assessment and intervention in family problems. Particular attention is paid to the assumptions basic to a systemic perspective.

**MS_FT 402-0 Methods of System Therapy (1 Unit)**
This course introduces students to a range of methods used in systems therapy. The methods will be drawn from the integrative traditions emphasized in The Family Institute Model and will prepare students to engage, work with and terminate cases.

**MS_FT 403-0 Self and Other Systems: Theory and Interventions (1 Unit)**
This course's purpose is to deepen students' understanding of self and systems. Particular emphasis will be given to aspects of self-development and the therapist's understanding of self when working with systems.

**MS_FT 410-0 Human Development and the Life Cycle (1 Unit)**
This course utilizes a development framework to understand individual human development across the life span and the dynamic interactions of individuals within families. Physical, cognitive, emotional, and social development will be presented at each age level, including issues regarding culture, gender and sexual orientation. Commonly presented problems and therapeutic interventions will be discussed for each age group.

**MS_FT 411-0 Intimate Relations (1 Unit)**
This course will elaborate on The Family Institute Model for working with couples, which involves great affective intensity and subtlety of communication. The most common problems that couples present, such as intense conflict, depression, sexual difficulties, separation and divorce, will be addressed.

**MS_FT 413-0 Intimate Relations II (1 Unit)**
This course is a continuation of MS_FT 411-0 in order to increase therapists’ competence with helping couples gain, rediscover and/or
maintain intimacy within their relationship. The course brings in cutting edge interventions and theory from the scientific study of relationships and offers students the opportunity to learn from the best of the best in the field of couple's therapy.

**MS_FT 414-0 Behavioral Medicine in Marriage and Family Therapy (1 Unit)**
This course is designed to introduce students to areas of health psychology and behavioral medicine. The goal of behavior medicine is to understand the intersection of mental and physical health. This class will cover a range of topics that are relevant to thinking about the impact of physical health on mental health and the impact of mental health on physical health processes. In particular, we will examine basic psychological processes that influence health and illness including but not limited to perceived control, stress, factors that influence behavioral change, self-efficacy and social support. We will also examine specific behaviors, illnesses, and physical conditions that are part of the behavioral medicine domain such as diet, obesity, exercise, smoking, cancer, and diabetes. Finally, we will consider all of the above issues in the broader social context.

**MS_FT 421-0 Systemic Assessment (1 Unit)**
Students will learn how to define the parameters of systemic assessment and how it differs from, and can be integrated with, individual assessment. Students will learn how systemic assessment operates within the current legal and medical context. Students will learn the DSM-IV diagnostic system and how to apply it systematically. Students will learn specific models and measures of systemic assessment, including formal family assessment measures.

**MS_FT 422-0 Family Research (1 Unit)**
Students completing the course will develop skills to understand common MFT research methods, how research methods are applied, and how to critique research in the field of marriage and family therapy and mental health. Students will also be introduced to empirically based practices in MFT.

**MS_FT 424-0 Group Therapy Internship (0 Unit)**
Course includes didactic, experiential, and clinical elements. Trainees learn the theoretical basis of group therapy and develop a framework for group work, learn the fundamentals of group dynamics by participation in a group, and co-lead a group. Course also addresses the business aspects of setting up and marketing a group.

**MS_FT 427-0 Family of Origin and Intrapsychic Work From a Systemic Perspective (1 Unit)**
Course offers a systemic perspective on the development of intrapsychic structure and function; therapeutic approaches for individuals, couples, and families, including family of origin and transgenerational approaches.

**MS_FT 428-0 Legal, Ethical and Professional Issues in Marital and Family Therapy (1 Unit)**
Legal issues in the practice of marriage and family therapy. Course objectives: Competence in handling the most significant legal issues, including confidentiality, danger, malpractice, and expert testimony. Awareness of the requirements of ethical practice, including an understanding of how your own values will impact your work. Development of a professional identity as a family therapist and an understanding of how to keep that identity current.

**MS_FT 429-0 Sex Therapy (1 Unit)**
A multidimensional/biophysical approach to the diagnosis and treatment of sexual difficulty in individuals and couples. Sexual problems discussed include disorders of desire, aversion, arousal, orgasm, and pain.

**MS_FT 430-0 Power, Privilege and Difference: Practicing Cultural Curiosity and Humility in a (1 Unit)**
Effective community-based work requires a focus on strengths and a valuing of diverse perspectives and talents. The course will review strategies for understanding how culture and context influence the therapeutic alliance individual functioning, how to gather information regarding context and how to use this information to intervene with diverse clients and settings. This course covers the implementation of The Family Institute Model with under-resourced clients and community settings.

**MS_FT 436-0 Family Therapy Treatment Models (1 Unit)**
Exploration of various approaches to family therapy as they are practiced. Important trends and controversies in the field will be examined, including the influence of race, culture, ethnicity and gender in the assessment and treatment processes. Treatment Models is a foundation course offered concurrently with the clinical internship. It stresses the progressive integration of class and practice experiences.

**MS_FT 437-0 Family Therapy with Children and Adolescents (1 Unit)**
This course will provide theoretical and practical knowledge in working with families that present with Children and Adolescents. A systemic framework will be employed as the basis for developing assessments and therapeutic objectives. Specific clinical issues will be covered, such as abuse, divorce and mood disorders, with the focus on assessment and interventions.

**MS_FT 440-0 Systemic Perspectives in the Treatment for Chemical-Dependency and Substance Abuse (1 Unit)**
This course reviews distinctions of disease model vs. systemic views of addiction and treatment; understanding the markers of abuse and dependence; illumination of various therapeutic approaches; efficacy of family therapy approaches. Students develop working theoretical and clinical knowledge of addiction treatment.

**MS_FT 480-0 Pre-Practicum in Marital & Family Therapy (1 Unit)**
This course is aimed to provide practical training in systemic therapy, including interviewing skills, initial assessments, and management of professional role. Course also focuses on the role of the therapists family background, personal experience, values, beliefs, and interpersonal style in conducting psychotherapy.

**MS_FT 481-0 Internship in Marital & Family Therapy (1 Unit)**
Clinical internship in the Bette D. Harris Family and Child Clinic under supervision by core faculty. Students gain practical experience in providing systematic assessment and treatment for clients. Begins winter quarter of the first year and continues through the summer; 1 credit per quarter.

**MS_FT 482-0 Internship in Marital & Family Therapy (1 Unit)**
Clinical internship, under supervision by core faculty, for 15 to 20 hours per week, beginning fall quarter of the second year and continuing for the duration of the program.

**MS_FT 495-0 Master of Science in Marriage and Family Therapy Capstone Project (0 Unit)**
The MSMFT Capstone involves the completion of a case study process, a case presentation and a paper that demonstrate the student's acquisition of clinical competence, as well as the ability to integrate relevant knowledge and skill within the framework of Integrative Systemic Therapy and apply this integration to their clinical work. The project demonstrates the student's ability to accomplish systemic integration in their practice and, thereby, their readiness to continue their professional growth through the integration of new learnings.

**MS_FT 499-0 Independent Study (1 Unit)**
Music (MUSIC)

MUSIC 421-2 Seminar in Music (1 Unit)
A study of essential music literature. Development of analytical, interpretive, and critical thinking ability. Application of this knowledge to the analysis and critical evaluation of music literature.

MUSIC 424-0 Qualitative Research in Music Education (1 Unit)
Intensive exploration of technique and assumptions related to qualitative research. Critiques of selected studies. Design and implementation issues as relevant to music education research. Development of a research project related to studies in the Center for the Study of Education and the Musical Experience. Presentation of the project to the Center.

MUSIC 425-0 Quantitative Research in Music Education (1 Unit)
Intensive exploration of technique and assumptions related to quantitative research. Critiques of selected studies. Design and implementation issues as relevant to music education research. Development of a research project related to studies in the Center for the Study of Education and the Musical Experience. Presentation of the project to the Center.

MUSIC 426-0 World Music Pedagogy (1 Unit)
Philosophies and practices of music education that either promote or hinder democratic approaches to student learning.

MUSIC 427-0 Teaching Exceptional Children (1 Unit)
This course covers U.S. legislation relating to the education of individuals with disabilities, specific disabilities and their impact on student learning, and the impact of racial, cultural, socioeconomic, gender, and neurological diversities on student learning, and accommodations, adaptations, and differentiation for the music classroom. Students engage in weekly community engaged service at a local school for children with disabilities.

MUSIC 430-0 Seminar in General Music Education (1 Unit)
Survey and critical examination of general music courses in elementary, middle, and junior high schools. Emphasis upon the comprehensive musicianship approach in developing criteria and teaching/learning strategies based upon principles of aesthetic education.

MUSIC 431-0 Seminar in Instrumental Music Education (1 Unit)
Principles of effective instruction in instrumental music classes and rehearsals. Topics include development of presentational skills, criteria for the selection of instructional materials, instrumental performance problems, and the development and implementation of a performance-based instrumental curriculum.

MUSIC 432-0 Seminar in Instrumental Music Education (1 Unit)
Principles of effective instruction in instrumental music classes and rehearsals. Topics include development of presentational skills, criteria for the selection of instructional materials, instrumental performance problems, and the development and implementation of a performance-based instrumental curriculum.

MUSIC 433-0 Seminar in Orchestral Conducting (1 Unit)
Survey and critical examination of orchestral and chamber conducting. Emphasis upon the development of presentational skills, criteria for the selection of instructional materials, and the development and implementation of a performance-based instrumental curriculum.

MUSIC 434-0 Seminar in Vocal Conducting (1 Unit)
Survey and critical examination of choral conducting. Emphasis upon the development of presentational skills, criteria for the selection of instructional materials, and the development and implementation of a performance-based instrumental curriculum.

MUSIC 435-0 Seminar on Music in Higher Education (1 Unit)
Historical overview of music in higher education; organization, administration, curricula, accreditation; faculty appointment and development; budget, management, accountability; contemporary issues.

MUSIC 436-0 Seminar on Music in Higher Education (1 Unit)
Historical overview of music in higher education; organization, administration, curricula, accreditation; faculty appointment and development; budget, management, accountability; contemporary issues.

MUSIC 437-0 Psychology of Music Teaching & Learning (1 Unit)
Theories in music psychology. Review of research related to the musical experience with emphasis on musical development, teaching, and learning.

MUSIC 438-0 Creative Thinking in Music (1 Unit)
Definitions and models of creative thinking in music. Review of important research in music psychology on creative thinking. Application of this information to creative teaching strategies in music.

MUSIC 439-0 Measurement and Evaluation in Music (1 Unit)
A study of the positivist-postpositivist debate and its implications for research in education. Research approaches as ideologies. Assumptions inherent in quantitative and qualitative research. Examination of exemplary studies in both ideologies and analysis of strengths and weaknesses of each. Applications to the design of studies in music education.
MUSIC_ED 441-0 Professional Practicum (1 Unit)
Field placement in an appropriate teaching or other professional situation.

MUSIC_ED 445-0 Music in the Interdisciplinary Curriculum (1 Unit)

MUSIC_ED 458-0 Philosophical Basis of Music Education (1 Unit)
Aesthetic theories relevant to music education; application of theory to practical problems of the music educator. Topics include art and feeling, the creative process, aesthetic meaning, aesthetic experience, musical meaning, and musical experience.

MUSIC_ED 463-0 Teaching High School Nonperformance Courses (1 Unit)

MUSIC_ED 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

MUSIC_ED 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit. - SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Music Technology (MUS_TECH)

MUS_TECH 300-0 Foundations of Music Tech for Music Majors (1 Unit)
Introduction of key concepts in acoustics, digital audio theory, production, and postproduction. Through projects and presentations, students will learn to record and edit their work, use notation software, communicate with recording engineers, and prepare and present work online.

MUS_TECH 321-0 Producing in the Virtual Studio (1 Unit)
Techniques for creating and producing music in the context of a computer-based audio production environment. Topics include MIDI, audio editing, plugins, effects processing, mastering, and basic surround mixing. Assignments include creative projects. Prerequisite: MUS_TECH 259-0 or equivalent experience and consent of instructor.

MUS_TECH 322-0 Recording Techniques (1 Unit)
Microphone and placement techniques including stereo and close/distant miking of voices, acoustic instruments, and ensembles. Console design, signal flow, and dynamics processing. Projects include recording assignments. Prerequisite: MUS_TECH 259-0 or equivalent experience and consent of instructor.

MUS_TECH 335-0 Selected Topics (1 Unit)
Topics vary; announced before registration. May be repeated.

MUS_TECH 336-0 Selected Topics in Music Cognition (1 Unit)
Topics vary; announced before registration. May be repeated.

MUS_TECH 355-0 Atonal Analysis (1 Unit)
Topics vary; announced before registration. May be repeated.

MUS_TECH 355-2 History and Analysis of Electroacoustic Music (1 Unit)
Survey of electronic music repertoire from 1948 through the end of the analog era and the introduction of digital music. Examination of the aesthetic motivations and technical approaches that have shaped electroacoustic music throughout its history, focusing on the interaction between technical innovation and creativity.

MUSIC_TECH 435-0 Selected Topics (1 Unit)
Topics vary. May be repeated for credit with change of topic.

MUSIC_TECH 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Music Theory (MUS_THRY)

MUS_THRY 317-0 Figured Bass (1 Unit)
The study of harmony at the keyboard as learned by musicians since the early 17th century. Figured bass is an essential subject for performers of early music (including Bach and Mozart) and a key to the analysis of most pre-20th century European music.

MUS_THRY 321-0 Analytical Techniques (1 Unit)
Detailed analysis of all parameters of selected musical examples; compositional procedures as a means of developing an intelligent rationale for interpretation. Prerequisite: MUSIC 211-3 or consent of instructor.

MUS_THRY 331-0 Analytical Studies (1 Unit)
Extension and refinement of concepts and techniques acquired in first and second year music theory.

MUS_THRY 335-0 Selected Topics in Music Theory (1 Unit)
Topics vary; announced before registration. May be repeated.

MUS_THRY 336-0 Selected Topics in Music Cognition (1 Unit)
Topics vary; announced before registration. May be repeated.

MUS_THRY 355-0 Atonal Analysis (1 Unit)
Techniques for analysis of atonal and nonfunctional tonal music, including serial, set-theoretic, and parametric approaches. Emphasis on music of Schoenberg, Webern, Berg, Stravinsky, and Debussy. Selected readings in analytic literature. Prerequisite: MUSIC 211-3 or equivalent.

MUS_THRY 400-0 Style Analysis (1 Unit)

MUS_THRY 405-0 Introduction to Research Methods in Music Theory and Cognition (1 Unit)

MUS_THRY 410-0 Music Theory Pedagogy (1 Unit)
Trends in the teaching of music theory. Developing skills through videotaped peer-teaching projects and reviews.

MUS_THRY 415-1 History of Music Theory (1 Unit)

MUS_THRY 415-2 History of Music Theory II (1 Unit)

MUS_THRY 420-0 Current Readings in Music Theory & Cognition (1 Unit)

MUS_THRY 422-0 Rhythm and Meter (1 Unit)
Close reading and discussion of key canonical texts from the last three decades' rich scholarship in rhythm and meter as well as innovative new work. Each student completes a substantial analytical and/or theoretical paper.

MUS_THRY 431-0 Topics in Advanced Analysis (1 Unit)
MUSICOL 335-0 Selected Topics in Music Theory (1 Unit)
Content varies. May be repeated for credit with change of topic.

MUSICOL 336-0 Selected Topics in Music Cognition (1 Unit)

MUSICOL 450-0 Seminar in Music Theory & Cognition (1 Unit)
Advanced graduate seminar on a current topic within music theory and/or cognition. Topics will reflect the professor's recent or current research.

MUSICOL 451-0 Music Cognition (1 Unit)

MUSICOL 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

MUSICOL 590-0 Research (1-4 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Musicology (MUSICOL)

MUSICOL 313-0 World Music Cultures (1 Unit)
Introduction to both the world's musical variety and common issues related to music cultures worldwide.

MUSICOL 323-0 Topics in Ethnomusicology (1 Unit)
Ethnomusicology history, bibliographical resources, methods, and theories. 

MUSICOL 326-0 Topics in World Music: Asia (1 Unit)
The musical traditions of South Asia, East Asia, and Southeast Asia. Topics include characteristics of instruments and instrumental ensembles, sound structures, theatrical traditions, and vocal performance.

MUSICOL 327-0 Topics in World Music: Africa (1 Unit)
Introduction to Africa's diverse musics through the multidisciplinary lens of ethnomusicology. Topics include music learning and transmission, aesthetics, musical styles and structures, performance practice, compositional process, musical change, and the role of music in society.

MUSICOL 328-0 Topics in World Music: The Americas (1 Unit)
An ethnomusicological perspective on music of the Americas as influenced by European, African, Hispanic, and native American cultures. The socioeconomic impact of jazz, rock, gospel, and popular music; the role of music in the spiritual and social life of the Americas' diverse peoples.

MUSICOL 329-0 Topics in Middle Eastern Music (1 Unit)
History, basic tenets, and aesthetic of Islam; the musics of Islamic cultures from North Africa, Spain, the Middle East, central Asia, and the Indian subcontinent. Methods of contextualizing musical cultures and critical methodology related to gender, postcolonial theory, and religion. 

MUSICOL 330-0 Russian Fairy Tale and Opera (1 Unit)
Russian cultural and national identity studied through folk tales and their musical counterparts in Russian opera. Current critical theory, the portrayal of women, the interplay of nationalism and gender, and the East-West dichotomy. 

MUSICOL 331-0 Orientalism and Music (1 Unit)
The imagery of the East in the music of the West expressed in musical genres of various historical periods; focus on romantic opera and contemporary musical culture. Orientalism as formulated by Edward Said, developed by John MacKenzie, and clarified through references in literature and the visual arts.

MUSICOL 332-0 Music and Gypsies (1 Unit)
Romany music from Hungary, Spain, the Balkans, Turkey, the Middle East, and India; Andalucian flamenco; 19th century opera and operetta (Bizet's Carmen, Verdi's La Traviata); instrumental works by Haydn, Liszt, Brahms, and others; and more recent "world" music phenomena.

MUSICOL 333-0 Topics in Popular Music (1 Unit)
Topics vary; announced before registration. May be repeated.

MUSICOL 335-0 Selected Topics (1 Unit)
Topics vary; announced before registration. May be repeated.

MUSICOL 338-0 Expressionism (1 Unit)
The interaction of music (Schoenberg, Berg, Webern, Hindemith, et al.) with painting (Kandinsky et al.), poetry (Stefan George et al.), theater (Wedekind, Brecht, et al.), and dance (Kurt Jooss et al.) in early-20th century Germany and Austria.

MUSICOL 339-0 Music and Gender (1 Unit)
The many intersections between music and ideas of gender; focus on composition, characterization, patronage, and performance. Elite and popular Western musical forms from the Middle Ages to 2000 in relation to gender issues in other cultures' musics.

MUSICOL 341-0 Music and the Visual Arts (1 Unit)
The many ways in which the senses of sight and hearing interact in Western images of music and music making as well as in select musical works inspired by concurrent ideas or movements in the visual arts.

MUSICOL 342-0 Authenticity (1 Unit)
Authenticity in music at the turn of the 21st century, focusing on three music genres most closely associated with that idea's cultural and philosophical considerations: early music, country music, and world or ethnic music.

MUSICOL 343-0 Music and Shakespeare (1 Unit)
An exploration of some of the many intersections between Shakespearean drama and music from the late 16th through early 21st centuries, including study of plays, opera, ballet, film, musical theater, art song, popular music, and the symphony.

MUSICOL 344-0 Music and Film (1 Unit)
Theory and practice of music as a part of the processes of making and viewing films, from the beginning of the sound era to the present. Topic varies but typically focuses on a specific film genre's musical traditions, techniques, personalities, and problems.

MUSICOL 345-0 From Literature to Opera to Film (1 Unit)
Selected operas, based on literary or theatrical works, that in turn inspired films. Examination of the literary or theatrical inspiration, the opera as written for stage, and film and video adaptations.

MUSICOL 346-0 Composer Topics (1 Unit)
Topics vary; announced before registration. May be repeated.

MUSICOL 347-0 The Lied (1 Unit)
Survey of voice-piano settings of German poems, from Mozart through Richard Strauss.

MUSICOL 348-0 Bel Canto Opera (1 Unit)
Italian opera in the early-to mid-19th century. The relations of Rossini, Donizetti, and Bellini to the operatic culture of their time.

MUSICOL 350-0 Topics in Medieval Music (1 Unit)
Gregorian and medieval chant, secular monophony, and the development of polyphony from the earliest records through the music of Ockeghem and Busnois.

MUSICOL 351-0 History of World Musical Traditions (1 Unit)

MUSICOL 352-0 The History of the Sonatas (1 Unit)

MUSICOL 353-0 Comparative Perspectives on Music (1 Unit)

MUSICOL 354-0 American Music Scholarship (1 Unit)

MUSICOL 355-0 Seminar in History of World Musical Traditions (1 Unit)

MUSICOL 356-0 Seminar in the History of the Sonatas (1 Unit)

MUSICOL 357-0 Seminar in Comparative Perspectives on Music (1 Unit)

MUSICOL 358-0 Seminar in American Music Scholarship (1 Unit)

MUSICOL 359-0 Seminar in History of World Musical Traditions (1 Unit)

MUSICOL 360-0 Seminar in the History of the Sonatas (1 Unit)

MUSICOL 361-0 Seminar in Comparative Perspectives on Music (1 Unit)

MUSICOL 362-0 Seminar in American Music Scholarship (1 Unit)

MUSICOL 363-0 Seminar in Research on Music (1 Unit)

MUSICOL 364-0 Seminar in Research on the History of World Musical Traditions (1 Unit)

MUSICOL 365-0 Seminar in Research on the History of the Sonatas (1 Unit)

MUSICOL 366-0 Seminar in Research on Comparative Perspectives on Music (1 Unit)

MUSICOL 367-0 Seminar in Research on American Music Scholarship (1 Unit)

MUSICOL 368-0 Seminar in Research on Research (1 Unit)

MUSICOL 369-0 Seminar in Research on Music (1 Unit)

MUSICOL 370-0 Seminar in Research on the History of World Musical Traditions (1 Unit)

MUSICOL 371-0 Seminar in Research on the History of the Sonatas (1 Unit)

MUSICOL 372-0 Seminar in Research on Comparative Perspectives on Music (1 Unit)

MUSICOL 373-0 Seminar in Research on American Music Scholarship (1 Unit)

MUSICOL 374-0 Seminar in Research on Research (1 Unit)

MUSICOL 375-0 Seminar in Research on Music (1 Unit)

MUSICOL 376-0 Seminar in Research on the History of World Musical Traditions (1 Unit)

MUSICOL 377-0 Seminar in Research on the History of the Sonatas (1 Unit)

MUSICOL 378-0 Seminar in Research on Comparative Perspectives on Music (1 Unit)

MUSICOL 379-0 Seminar in Research on American Music Scholarship (1 Unit)

MUSICOL 380-0 Seminar in Research on Research (1 Unit)

MUSICOL 381-0 Seminar in Research on Music (1 Unit)

MUSICOL 382-0 Seminar in Research on the History of World Musical Traditions (1 Unit)

MUSICOL 383-0 Seminar in Research on the History of the Sonatas (1 Unit)

MUSICOL 384-0 Seminar in Research on Comparative Perspectives on Music (1 Unit)

MUSICOL 385-0 Seminar in Research on American Music Scholarship (1 Unit)

MUSICOL 386-0 Seminar in Research on Research (1 Unit)

MUSICOL 387-0 Seminar in Research on Music (1 Unit)

MUSICOL 388-0 Seminar in Research on the History of World Musical Traditions (1 Unit)

MUSICOL 389-0 Seminar in Research on the History of the Sonatas (1 Unit)

MUSICOL 390-0 Seminar in Research on Comparative Perspectives on Music (1 Unit)

MUSICOL 391-0 Seminar in Research on American Music Scholarship (1 Unit)

MUSICOL 392-0 Seminar in Research on Research (1 Unit)

MUSICOL 393-0 Seminar in Research on Music (1 Unit)

MUSICOL 394-0 Seminar in Research on the History of World Musical Traditions (1 Unit)

MUSICOL 395-0 Seminar in Research on the History of the Sonatas (1 Unit)

MUSICOL 396-0 Seminar in Research on Comparative Perspectives on Music (1 Unit)

MUSICOL 397-0 Seminar in Research on American Music Scholarship (1 Unit)

MUSICOL 398-0 Seminar in Research on Research (1 Unit)

MUSICOL 399-0 Seminar in Research on Music (1 Unit)
MUSICOL 351-0 Topics in 16th Century Music (1 Unit)
Middle and late renaissance and early manifestations of the baroque, from Josquin through the Gabriels.

MUSICOL 352-0 Topics in 17th Century Music (1 Unit)
The baroque from Monteverdi through Bach and Handel.

MUSICOL 353-0 Topics in 18th Century Music (1 Unit)
Representative works and critical studies of European art music from the Arcadian reform of opera through the Napoleonic era.

MUSICOL 354-0 Topics in 19th Century Music (1 Unit)
Representative works and critical studies of European art music from the Congress of Vienna to the death of Mahler.

MUSICOL 355-0 Topics in 20th Century Music (1 Unit)
Representative works and critical studies of art music from Debussy to the late 20th century.

MUSICOL 400-0 Graduate Review of Music History (1 Unit)

MUSICOL 423-0 Seminar in Ethnomusicology (1 Unit)
Selected topics; application of ethnomusicological techniques to research projects.
Prerequisite: MUSICOL 323-0 or consent of instructor.

MUSICOL 424-0 Fieldwork Methods (1 Unit)

MUSICOL 429-0 Topics in Middle Eastern Music (1 Unit)
Topics vary by quarter.

MUSICOL 430-0 Russian Fairy Tale and Opera (1 Unit)

MUSICOL 433-0 Topics in Popular Music (1 Unit)

MUSICOL 435-0 Selected Topics (1 Unit)
Topics vary. May be repeated for credit with change of topic.

MUSICOL 439-0 Seminar in Music and Gender (1 Unit)

MUSICOL 441-0 Seminar in Music and Visual Arts (1 Unit)

MUSICOL 442-0 Authenticity (1 Unit)
Focus on authenticity in music at the end of the 20th century and beginning of the 21st century by examining the three music genres most closely associated with the cultural and philosophical considerations of the idea: early music, country music, and "world" or "ethnic" music.

MUSICOL 443-0 Seminar in Music and Shakespeare (1 Unit)

MUSICOL 444-0 Seminar in Music and Film (1 Unit)

MUSICOL 445-0 From Literature to Opera to Film (1 Unit)
Selected operas, based on literary or theatrical works, that in turn inspired films. Examination of the literary or theatrical inspiration, the opera as written for stage, and film and video adaptations.

MUSICOL 448-0 Seminar in Wagner (1 Unit)

MUSICOL 450-0 Seminar in Medieval Music (1 Unit)

MUSICOL 451-0 Seminar in Early Modern Music (1 Unit)

MUSICOL 452-0 Seminar in 17th Century Music (1 Unit)

MUSICOL 453-0 Seminar in 18th Century Music (1 Unit)

MUSICOL 454-0 Seminar in 19th Century Music (1 Unit)

MUSICOL 455-0 Seminar in 20th Century Music (1 Unit)

MUSICOL 457-0 Seminar in Opera (1 Unit)

MUSICOL 458-0 Seminar in Art Song (1 Unit)

MUSICOL 459-0 Seminar in Sacred Music (1 Unit)

MUSICOL 460-0 Notation and Editing (1 Unit)

MUSICOL 461-0 Epistemologies of Music (1 Unit)

MUSICOL 490-0 Musicology Colloquium (0 Unit)

MUSICOL 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

MUSICOL 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit. SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Neurobiology & Physiology (NEUROBIO)

NEUROBIO 401-0 Introduction to Neurobiology (2 Units)
This course introduces students in the MS Program in Neurobiology to the basics of modern day neurosciences, and canonical experiments that provide the foundation of modern day research. This course is currently not offered.

NEUROBIO 402-0 Advanced Neurobiology and Physiology (2 Units)
This course highlights cutting-edge research in neurobiology through interactive research lectures and critical discussion of primary literature. Topics vary annually but include subjects such as sensory neurobiology, chronobiology, synaptic physiology, and neurodegenerative diseases.

NEUROBIO 499-0 Independent Study (1-3 Units)
Supervised individual work; does not fulfill requirements for thesis or dissertation. Quarters offered: fall, winter, spring. - SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

NEUROBIO 595-0 Master’s in Science in Neurobiology Laboratory Research (1-3 Units)

Neuroscience (NEUROSCI)

NEUROSCI 303-0 Molecular Mechanisms of Neuropsychopharmacology (1 Unit)
Advanced seminar focusing on molecular mechanisms and aberrations of synaptic signal transduction and drugs that target them.
Prerequisite: NEUROSCI 202-0 or NEUROSCI 311-0 or BIOL_SCI 302-0.

NEUROSCI 304-0 Developmental Neurobiology (1 Unit)
Embryology and cellular/molecular mechanisms of nervous system development. Topics include patterning of the early nervous system, neurogenesis, neuronal differentiation, wiring of neural circuits, activity and experience-dependent development and sex differences in early and late development. May not receive credit for both this course and the former BIOL_SCI 304-0.
Prerequisites: BIOL_SCI 215-0; and NEUROSCI 202-0 or NEUROSCI 311-0 or BIOL_SCI 302-0.

NEUROSCI 311-0 Biophysical Analysis of Neurons for ISP (1 Unit)
Introduction to the organization and function of brain systems and their role in generating behavior. May not receive credit for both this course and the former NEUROSCI 306-0/BIOL_SCI 306-0.
Prerequisites: NEUROSCI 202-0 or NEUROSCI 311-0 or BIOL_SCI 302-0; and must be a neuroscience major.

NEUROSCI 320-0 Animal Behavior (1 Unit)
Animal behavior from the neuroscience perspective. Neurobiological bases of foraging, communication, migration, predator-prey interactions, mating, and parental care.
Prerequisites: NEUROSCI 202-0 and NEUROSCI 206-0; or NEUROSCI 311-0 and NEUROSCI 206-0; or BIOL_SCI 302-0.
Natural Sciences Distro Area

NEUROSCI 360-0 Neuroscience of Brain Disorders (1 Unit)
Survey of brain disorders such as neurodegenerative diseases, developmental disorders, narcolepsy, and migraine. Trace progress from the laboratory to the clinic, evaluate the state of knowledge and understand future directions. Strongly recommend review of basic genetics and molecular biology.
Prerequisites: NEUROSCI 202-0 and NEUROSCI 206-0; or NEUROSCI 311-0 and NEUROSCI 206-0; or BIOL_SCI 302-0.
Natural Sciences Distro Area

NEUROSCI 377-0 Neurobiology of Sensation and Perception (1 Unit)
Analysis of the key concepts underlying the neurobiological mechanisms of vision, hearing, taste, smell, touch, and pain. Neural pathways leading to perception and processing of stimuli will also be discussed.
Prerequisite: NEUROSCI 202-0 or NEUROSCI 311-0 or BIOL_SCI 302-0.
Natural Sciences Distro Area

Neuroscience (NUIN)

NUIN 401-1 Fundamentals of Neuroscience (2 Units)
This course covers fundamentals concepts pertaining to the genetics, cell biology, and physiology of neurons. Major topics include gene expression and regulation, protein production and trafficking, neuronal ultrastructure, glial physiology, electrophysiology and membrane biophysics, synaptic communication and plasticity, receptor/neurotransmitter pharmacology, and signal transduction.

NUIN 401-2 Fundamentals of Neuroscience (1 Unit)

NUIN 401-3 Fundamentals of Neuroscience (1 Unit)

NUIN 408-0 Quantitative Methods and Experimental Design (1 Unit)

NUIN 411-1 Great Experiments in Molecular and Developmental Neuro Science (1 Unit)

NUIN 411-2 Great Experiments in Cellular Neurophysiology (1 Unit)

NUIN 411-3 Great Expts in System & Cognitive Neuroscience (1 Unit)

NUIN 417-0 Proteinopathies: Alzheimer’s Disease as a Case Study (1 Unit)

NUIN 418-0 Assembly of Neural Circuits (1 Unit)

NUIN 421-0 Circadian Rhythms (1 Unit)

NUIN 424-0 Sensory Transduction and Early Visual Processing (1 Unit)

NUIN 430-1 Introduction to Neuroscience Research (0 Unit)

NUIN 433-0 The Neurobiology of Disease (1 Unit)

NUIN 436-0 Drugs and the Brain (1 Unit)
Graduate neuropharmacology course with a mix of didactic instruction (33%) and in-depth classroom discussion of primary research papers (66%). The course is not a survey course, but rather will cover selected topics in neuropharmacology with the goals of 1) informing the student of the latest neuropharmacology knowledge, 2) inculcating a rigorous approach to examination of the scientific literature, and 3) encouraging best practices in experimental design.

NUIN 438-0 Cellular and Molecular Aspects of Motor Neuron Biology (1 Unit)
This course is designed to expose students to the current findings and developments in the field of motor neuron biology in the context of development, health, and disease. Both cortical and spinal components of motor neuron circuitry will be discussed in depth.

NUIN 440-0 Advanced Neuroanatomy (1 Unit)

NUIN 441-0 Biophysical Signal Processing for Movement & Rehabilitation Sciences (1 Unit)

NUIN 442-0 Issues in Movement & Rehabilitation Science (1 Unit)

NUIN 455-0 Instrumentation for Neuroscience (1 Unit)

NUIN 460-0 Interneurons and Brain Networks (1 Unit)

NUIN 462-0 Cortical Circuit Organization (1 Unit)

NUIN 470-0 Cellular & Molecular Basis of Information Storage (1 Unit)

NUIN 473-0 Cellular and Behavioral Mechanisms of Aging and Dementia (1 Unit)

NUIN 475-0 Nerve Excitation and Synaptic Transmission (1 Unit)

NUIN 478-0 Neuropharmacology of Brain Disorders (1 Unit)

NUIN 480-0 Neural Control of Movement (1 Unit)

NUIN 481-0 Neural Mechanism of Pain (1 Unit)

NUIN 486-0 The Biology of Sleep (1 Unit)

NUIN 490-0 Responsible Conduct in Neuroscience Research (0 Unit)

NUIN 493-0 MOLECULAR BASIS OF NATURAL HISTORY (0 Unit)
The molecular basis of natural history course will examine important examples from Nature and use the approaches of biochemistry, molecular biology and genetics to categorize and analyze the natural products produced by bacteria, plants and animals and examine how they have impacted human history. Most 2 hour sessions will be devoted to a particular topic. After an introduction by faculty, course participants will examine the subject further through the discussion of assigned papers from the literature or other texts. Some sessions will also be devoted solely to presentations of topics by the students. All students will submit and essay on a topic covered by the course or a related topic in natural history.

NUIN 495-0 Topics in Neuroscience (1 Unit)

NUIN 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

NUIN 510-0 Advanced Topics in Visual Science (0 Unit)

NUIN 550-0 Postbaccalaureate Neuroscience Research (0 Unit)
Research conducted with a faculty mentor as part of the Interdepartmental Neuroscience (NUIN) Post-Baccalaureate program.

NUIN 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Operations Management (OPNS)

OPNS 510-0 Stochastic Calculus and Control (1 Unit)
Ito Calculus, Ito, equations, SDEs and their applications to performance evaluation, dynamic control of manufacturing and service operations, and telecommunications systems; heavy traffic approximations.

OPNS 516-0 Stochastic Foundations (1-4 Units)
The first part of the course covers basic concepts in probability; the second part renewal and regenerative processes including Markov chains; and the last part Martingales and Brownian motion. Throughout, theoretic results are applied to the analysis of queues. Students are expected to have some background in probability (e.g., IEMS 202-0) and stochastic processes; no measure theory background is required.

OPNS 521-0 Foundations of Operations Management (1 Unit)
This course will introduce PhD students to the basic models used in academic research of operations management. As such, we will survey a broad array of "research content" (basic models and approaches in the
OPNS 522-0 Queueing Networks: Models, Algorithms and Emerging Applications (1 Unit)
Queues are everywhere: supermarket checkout, call centers, manufacturing assembly lines, wireless networks, and multitasking computers. Queueing theory provides a rich and useful set of mathematical models for the analysis and design of such systems. This course explores both theory and application of fundamental and advanced models in this field, with three broad parts: Preliminary tools, Novel Models and Applications.

OPNS 523-0 Estimation of Dynamic Programs (1 Unit)
This seminar will cover methods for estimating empirical dynamic discrete choice models. We will put the econometric theory to practice with weekly computer lab sessions and several rigorous programming assignments. We will study applications from the operations management area, including inventory control, supply chain coordination, service operations, and facility positioning.

OPNS 524-0 Empirical Methods in Operations Management (1 Unit)
This course examines: (1) how to critically read empirical studies, (2) how to ask questions that are interesting and worthwhile studying empirically, (3) what each method of causal inference (e.g. instrumental variables, panel data methods, regression discontinuity, etc.) does and why, when, and how to use each method, and (4) how an empirical researcher goes from an idea to a finished paper.

OPNS 525-0 Emerging Areas in Operations Management (1 Unit)
This course studies novel, emerging topics and methods used in academic research of operations management. Content will depend on the expertise and interests of the instructor. Past content included statistical (machine) learning and sequential decision-making, such as bandit learning, balancing exploration/exploitation, and reinforcement learning, including methods for value function approximation and algorithms for efficient exploration.

OPNS 590-0 Research (3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Performance Studies (PERF_ST)

PERF_ST 307-1 Studies in Gender and Performance (1 Unit)
Introduction to theories on gender in relation to selected literary texts. How gender is prescribed, reinforced, and transgressed; how race, class, and sexuality disrupt and/or affirm these representations.

PERF_ST 307-2 Studies in Gender and Performance (1 Unit)
Examination of theories of gender performance from a cultural studies perspective. Close attention to live performance, including drag, performance art, and film. A third course in this series (THEATRE 344-0) is offered by the Department of Theatre.

PERF_ST 308-0 Performing Modern & Contemporary Poetry (1 Unit)
Use of performance in the analysis and criticism of modern and contemporary poetry.

PERF_ST 310-0 Performance of Women of Color (1 Unit)
Literary expressions by native, Latina, African, and Asian American women reflecting intersections of gender, sexuality, ethnicity, class, and culture in the United States. Feminisms considered across race and culture. Includes poetry, fiction, autobiography, drama, and critical theory.

PERF_ST 311-0 Performance in Everyday Life (1 Unit)
Conceptual view of human beings as actors. Dramatism and the perspective of life as theatre.

PERF_ST 314-0 Postcolonial Theory, Fiction, & Film (1 Unit)

PERF_ST 315-0 Non-Fiction Studies (1 Unit)
Exploration of the dramatic impulse in nonfiction texts. Emphasis on autobiographical one-person shows.

PERF_ST 316-0 Folktale and Oral Traditions (1 Unit)
Genres of oral literature and an introduction to the methods and aims of folklore research. The nature of verbal art as performance and the importance of cultural context.

PERF_ST 318-1 Shakespeare's English Histories (1 Unit)
Use of performance in the analysis and criticism of Shakespeare's two tetralogies of English history plays.

PERF_ST 318-2 Shakespeare Adaptations (1 Unit)
Use of performance in the analysis and criticism of selected Shakespeare plays and their adaptations by other writers.

PERF_ST 320-0 Languages of the Body (1 Unit)
Nonverbal body movement and gestural vocabularies in theatre, dance, and performance art (with reference to cinema and to productions of the body in the visual and commercial media); uses illustrations specific to a particular genre, repertoire, historical time, cultural context, and/or performance situation.

PERF_ST 321-0 Performing the American Fifties (1 Unit)
Use of performance in the analysis and criticism of selected postwar American literature.

PERF_ST 322-1 Staging the Novel (1 Unit)
Theory and practice of adapting novels for stage performance. Film adaptation as a model for stage adaptation.

PERF_ST 322-2 Staging the Novel (1 Unit)
Theory and practice of adapting novels for stage performance. Staging narrative voice and style; fiction in relation to nonfiction.

PERF_ST 324-1 Presentational Aesthetics (1 Unit)
Theatrical convention, presentational mode, and conscious artifice in the performance of dramatic literature, poetry, and nonfiction.

PERF_ST 326-1 Performance Art (1 Unit)
History, development, and theories of performance art as a live-art genre from the modernist avant-garde to contemporary cross-cultural forms. Media in all forms, with emphasis on performance process and audience relationship.

PERF_ST 326-2 Performance Art (1 Unit)
Further theoretical and laboratory exploration of compositional processes and political strategies of performance, media, and event/ audience contexts.

PERF_ST 327-0 Performance Ethnography (1 Unit)
Ethnographic approaches to the field of performance studies, including the theoretical foundations of performance ethnography and methodological approaches to its performance.

PERF_ST 328-0 Studies in James Joyce (1 Unit)
Primary emphasis on extensive critical study and performance of Joyce's Ulysses, resulting in either a lecture-performance, a recital, or a research paper.

PERF_ST 329-0 Performing Individual Poetic Styles (1 Unit)
Content varies. Major poems of a significant writer or writers, permitting in-depth encounter with the writer, cultural context, and performance related issues.

PERF_ST 330-0 Topics in Performance Studies (1 Unit)
Readings, discussion, and creative work in performance studies research and artistic practice. Topics vary. May be repeated for credit.

PERF_ST 331-0 Field Study/Internship in Performance Studies (1-4 Units)
Intensive participation in off-campus production and/or field research experience. Departmental approval required.

PERF_ST 332-0 Urban Festivity (1 Unit)
Ethnographic study of festivals, parades, exhibitions, civic celebrations, and other genres of urban cultural performance. Multiethnic expressions of Chicago identity. Field research methods.

PERF_ST 334-0 Human Rights & Performance (1 Unit)
How social movements, local communities, and individual activists from specific regions around the world use performance to seek political empowerment and social justice. Performance as theory, method, and event in the arts of resistance; human rights as ideology and praxis within indigenous histories, imaginaries, and contexts.

PERF_ST 335-0 Social Art Tactics (1 Unit)
Exploration of historical and theoretical foundations of social art practice, including work focused on social change in such genres as performance, digital media, relational art, and photography. Performance/ art workshops; development of performance-based interventions.

PERF_ST 336-0 Latino/a Performance (1 Unit)
Exploration of US Latina/o literature through narratives of migration, annexation, exile, and diaspora; focus on the arrival and development of Latina/o performance traditions in the United States.

PERF_ST 338-0 Family Stories, Memoirs and Diaries (1 Unit)
Use of performance to explore family stories, memoirs, diaries, and other biographical and autobiographical sources.

PERF_ST 410-0 Studies in Performance (1 Unit)
Principles governing the congruence of literary texts and their oral presentation.

PERF_ST 412-0 Perf of Individual Literary Styles (1 Unit)
Critical study of the work of one writer, resulting in a lecture recital.

PERF_ST 414-0 Studies in the History of Performance Traditions (1 Unit)
Critical writings from ancient times to the present, tracing uses of and development in the performance of text; analysis of contemporary principles and practices.

PERF_ST 416-0 Seminar in Cultural Studies & Performance (1 Unit)
Contemporary theories on the dialogical relationship between culture and performance (performative anthropology, interpretive and symbolic ethnography). Creative, dynamic, and processual energies of culture as expressed in performance genres.

PERF_ST 424-0 Practicum: Adaptation/Staging of Texts (1 Unit)
Participatory apprenticeship seminar: observation of the scripting process and rehearsal for a production of a narrative work. Major research papers by seminar members.

PERF_ST 426-0 Seminar on Media and Performance (1 Unit)
Interdisciplinary seminar introducing methods of performance research that explore, both analytically and creatively, the movement of performance across the traditional boundaries of the live arts and the visual and electronic media.

PERF_ST 427-0 Seminar on Modes of Representation (1 Unit)
Theories of representation applied to performance; repetition and improvisation, the ideology of form, intertextuality, metaphor, irony, parody, synesthesia, idiosyncratic, and effort qualities in human action.

PERF_ST 499-0 Independent Study (1 Unit)
Intensive study of one or a small number of major contributions to the existentialist tradition.

**PHIL 321-0 Philosophy & Gender (1 Unit)**
Survey of approaches to sex and gender throughout the history of philosophy.

**PHIL 324-0 Studies in African American Philosophy (1 Unit)**
Study of the work of one or more important African American philosophers or philosophical movements of the 19th or 20th centuries. May be repeated for credit with change of topic.

**PHIL 325-0 Philosophy of Mind (1 Unit)**
Selected topics in the philosophy of mind: mind-body problem, problem of other minds, self-knowledge, personal identity, philosophical psychology. May be repeated for credit with change of topic.

**PHIL 326-0 Philosophy of Medicine (1 Unit)**
Introduces premed students to ethical problems they are likely to encounter. For example: Is it ever ethical to withhold information from a patient? Should physicians help terminally ill patients commit suicide? Should health care for the elderly be more limited than for children? *Ethics Values Distro Area*

**PHIL 327-0 Philosophy of Psychology (1 Unit)**
Problems such as the nature of psychological explanation, experimentation and the testing of psychological claims, the standing of psychology as a science, reductionism, the unconscious, and conceptualizing the psyche and its processes.

**PHIL 328-0 Classics of Analytic Philosophy (1 Unit)**
Examination of classic texts that shaped the analytic movement of 20th century Anglo-American philosophy. Readings from Frege, Russell, Wittgenstein, Carnap, Quine, and others.

**PHIL 330-0 Practical Reasoning and Choice (1 Unit)**
Theory of decision making, what it is to decide, possible constraints on decisions, how to understand preference reversals, paradoxes of decision making, and actions taken against one's better judgment. Prerequisite: PHIL 150-0.

**PHIL 350-0 Advanced Logic (1 Unit)**
Alternating topics. Metalogic: Formal semantics, soundness, completeness, and compactness of predicate logic; Nonstandard models of arithmetic and the Lowenheim-Skolem theorems. Incompleteness: Recursive functions, the incompleteness of arithmetic and undecidability of predicate logic. Definability and undefinability of provability, consistency, and truth in arithmetic. Third quarter of PHIL 150-0/PHIL 250-0/PHIL 350-0 sequence. Prerequisite: PHIL 150-0.

**PHIL 351-0 Advanced Topics in Philosophical Logic (1 Unit)**
Advanced application of methods of modern formal logic to a variety of questions in metaphysics, philosophy of logic, philosophy of language, and philosophy of mathematics. Prerequisite: PHIL 250-0.

**PHIL 352-0 Philosophy of Mathematics (1 Unit)**
Nature of mathematical entities and mathematical truth. Platonism, intuitionism, fictionalism, nominalism, the synthetic a priori, self-referential paradoxes, incompleteness and undecidability, consistency, alternative axiomatizations and uniqueness, the relation between mathematics and logic, and mathematical revolutions.

**PHIL 353-0 Philosophy of Language (1 Unit)**
The nature and uses of language as presenting philosophical problems, e.g., theory of reference, the modes of meaning, definition, metaphor, problems of syntax, and semantics. May be repeated for credit with change of topic.

**PHIL 355-0 Scientific Method in the Social Sciences (1 Unit)**
Analysis of the philosophical foundations of social inquiry with reference to selected problems, thinkers, and schools, both classical and modern.

**PHIL 357-0 Topics in Metaphysics and Epistemology (1 Unit)**
Examination of current debates in metaphysics and epistemology, broadly understood. Possible topics include skepticism, mental representation, time, the epistemology of testimony, linguistic norms, personal identity, causation, and modality. May be repeated for credit with change of topic.

**PHIL 358-0 Epistemology (1 Unit)**
Central problems in the theory of knowledge, emphasizing contemporary developments. A priori knowledge, perception memory, induction, and theories of meaning and truth.

**PHIL 359-0 Studies in Metaphysics (1 Unit)**
The most general features of reality and their relation to thought and language. Topics may include existence, time, identity, properties, truth, causality, and freedom.

**PHIL 360-0 Topics in Moral Philosophy (1 Unit)**
Philosophical analysis of recent or contemporary issues, theories, or figures in moral philosophy. May be repeated for credit with change of topic.

**PHIL 361-0 Topics in Social and Political Philosophy (1 Unit)**
Philosophical analysis of a recent or contemporary issue, individual philosopher, or school of thought in social and political philosophy. May be repeated for credit with change of topic.

**PHIL 362-0 Studies in the History of Ethical and Political Theory (1 Unit)**
Examination of one or more major figures or movements in the history of moral or political philosophy. May be repeated for credit with change of topic.

**PHIL 363-0 Kant's Moral Theory (1 Unit)**
Exploration of the moral and ethical thought of Immanuel Kant through careful study of Groundwork of the Metaphysics of Morals along with readings from the Critique of Practical Reason, Metaphysics of Morals, and Religion within the Bounds of Mere Reason. *Ethics Values Distro Area*

**PHIL 366-0 Advanced Studies in the Philosophy of Religion (1 Unit)**
Central problems in the philosophy of religion.

**PHIL 370-0 Philosophy & Literature (1 Unit)**
Issues involving the relationship between philosophy and literature.

**PHIL 380-0 Philosophy of Art (1 Unit)**
Topics to be discussed might include the nature and purpose of art, art and perception, the nature of creativity, and the social responsibility of the artist.

**PHIL 390-0 Special Topics in Philosophy (1 Unit)**
May be repeated for credit with change of topic.

**PHIL 401-1 Proseminar (1St-Yr Philosophy Grad Students Only) (1 Unit)**
Essential aspects of philosophical inquiry, culminating in the production of professional-quality writing. Subject matter varies between value theory and metaphysics/epistemology. Limited to first-year graduate students in philosophy.

**PHIL 401-2 Proseminar (1St Yr Grad Students Only) (1 Unit)**
Essential aspects of philosophical inquiry, culminating in the production of professional-quality writing. Subject matter varies between value
PHIL 467-0 Seminar in Critical Race Theory (1 Unit)
Essential aspects of philosophical inquiry, culminating in the production of professional-quality writing. Subject matter varies between value theory and metaphysics/epistemology. Limited to second-year graduate students in philosophy.

PHIL 462-0 Seminar in Social and Political Theory (1 Unit)
Topics vary. May be repeated with change of topic.

PHIL 460-0 Seminar in Ethical Theory (1 Unit)
Theories of existence and reality.

PHIL 459-0 Seminar in Metaphysics (1 Unit)
Theories of existence and reality.

PHIL 458-0 Seminar in Value Theory (1 Unit)
Egoism; altruism; the analysis of good, right, and virtue; duty and the is-ought controversy; relativism; ethical motivation; justice; free will and determinism; utilitarianism; deontological ethics; happiness.

PHIL 457-0 Seminar in Social and Political Theory (1 Unit)
Study of an important problem, author, or school in social and/or political philosophy. Topics vary. May be repeated with change of topic.

PHIL 456-0 Seminar in Critical Race Theory (1 Unit)
Advanced philosophical work relating to theories of race, racism, and racial identity.

PHIL 455-0 Seminar in Epistemology (1 Unit)
Skepticism, perception, other minds, memory, inference, the analysis of knowledge-claims, and induction.

PHIL 454-0 Professional Skills Course (0 Unit)
Training and preparation for the job application process, and broader professional activities, including publication and conference participation.

PHIL 453-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS May be repeated for credit. Permission of instructor and department required.

PHIL 452-0 Seminar in German Philosophy (1 Unit)
Topics, individual figures, or developments in German philosophy from Kant until the present. Likely philosophers to be studied include Kant, Nietzsche, Heidegger, or Habermas.

PHIL 451-0 Seminar in French Philosophy (1 Unit)
Close critical reading of important texts in French philosophy. Likely philosophers to be studied include Maurice Merleau-Ponty, Emmanuel Levinas, Jacques Derrida, Jean-Luc Nancy, Luce Irigaray, and Julia Kristeva.

PHIL 450-0 Philosophy of Logic (1 Unit)
Philosophical aspects of formal systems. Logic and ontology. Nominalism and realism in the 20th century. Theories of the nature of mathematics.

PHYSICS 412-0 Quantum Mechanics (1 Unit)
1. Vector spaces, linear operators, Hermitian operators, stationary states, bound states, harmonic oscillator, symmetry and conservation laws, intrinsic spin, Stern-Gerlach experiment, and spherically symmetric potentials. 2. Schrödinger’s equation, electromagnetic potentials, approximation methods, variational principles, Dirac’s theory of the electron, electron spin, magnetic moment of the electron, and fine structure of hydrogen. 3. Identical particles, exchange symmetry, atomic and molecular structure, coherent states, time-dependent perturbations, transition amplitudes, spontaneous emission, photoelectric effect, scattering theory, and light scattering.

PHYSICS 411-0 Classical Mechanics (1 Unit)
Newtonian mechanics, conservation laws, and rigid-body dynamics; variational principle; Lagrangians, constraints, symmetry, conservation laws, non-potential forces, scattering, and linear oscillations; Hamiltonians, Poisson brackets, perturbation theory; and continuum dynamics.

PHYSICS 410-0 Seminar: Special Topics in Philosophy (1 Unit)
N/A.

PHYSICS 409-0 Seminar in Social and Political Theory (1 Unit)
Topics vary. May be repeated with change of topic.

PHYSICS 408-0 Seminar in Value Theory (1 Unit)
Egoism; altruism; the analysis of good, right, and virtue; duty and the is-ought controversy; relativism; ethical motivation; justice; free will and determinism; utilitarianism; deontological ethics; happiness.

PHYSICS 407-0 Seminar in Social and Political Theory (1 Unit)
Study of an important problem, author, or school in social and/or political philosophy. Topics vary. May be repeated with change of topic.
approximation methods, variational principles, Dirac's theory of the electron, electron spin, magnetic moment of the electron, and fine structure of hydrogen. 3. Identical particles, exchange symmetry, atomic and molecular structure, coherent states, time-dependent perturbations, transition amplitudes, spontaneous emission, photoelectric effect, scattering theory, and light scattering.

PHYSICS 414-1 Electrodynamics (1 Unit)
1. Electrostatics, boundary-value problems, multipole, electrostatics of macroscopic media, conductors and dielectrics, magnetostatics, Maxwell's equations, electromagnetic waves and gauge transformations, and conservation laws. 2. Special theory of relativity, Lorentz transformations, covariant formulation of electrodynamics, electrodynamics of charged particles, radiation by moving charges, retarded potentials, Cerenkov radiation, synchrotron radiation, and bremsstrahlung.

PHYSICS 414-2 Electrodynamics (1 Unit)
1. Electrostatics, boundary-value problems, multipole, electrostatics of macroscopic media, conductors and dielectrics, magnetostatics, Maxwell's equations, electromagnetic waves and gauge transformations, and conservation laws. 2. Special theory of relativity, Lorentz transformations, covariant formulation of electrodynamics, electrodynamics of charged particles, radiation by moving charges, retarded potentials, Cerenkov radiation, synchrotron radiation, and bremsstrahlung.

PHYSICS 416-0 Introduction to Statistical Mechanics (1 Unit)
Correlation functions, response theory, spontaneous symmetry breaking, phase transitions, fluctuations, and critical phenomena. Optionally: topics from condensed-matter physics, or nonequilibrium processes relevant to biophysics and economics.

PHYSICS 420-0 Statistical Physics (1 Unit)
Lectures and experimental demonstrations on the theory and phenomenology of superconductivity and its applications. No graduate prerequisites.

PHYSICS 421-0 Introduction to Superconductivity (1 Unit)
Lectures and experimental demonstrations on the theory and phenomenology of superconductivity and its applications. No graduate prerequisites.
PHYSICS 432-1 Many-Body Theory (1 Unit)
Correlation, response, and Green's functions for many-particle systems; Feynman perturbation theory, Dyson's equation, symmetry and conservation laws, Fermi liquids, quasiparticles, Landau's transport equation, electron-ion plasma, electron-phonon interaction, Kondo effect, BSC theory, Gorkov's equations; thermodynamic and magnetic properties of superconductors; transport equations and electromagnetic response of superconductors.

PHYSICS 432-2 Many-Body Theory (1 Unit)
Correlation, response, and Green's functions for many-particle systems; Feynman perturbation theory, Dyson's equation, symmetry and conservation laws, Fermi liquids, quasiparticles, Landau's transport equation, electron-ion plasma, electron-phonon interaction, Kondo effect, BSC theory, Gorkov's equations; thermodynamic and magnetic properties of superconductors; transport equations and electromagnetic response of superconductors.

PHYSICS 434-0 Quantum Fluids, Solids, and Gases (1 Unit)
Bose-Einstein condensation, hydrodynamic and collisionless sound, superfluidity in Bose systems, broken symmetry and BCS pairing, excitations and particle-hole coherence, and superfluid 4He and 3He in films and channels.

PHYSICS 435-0 Soft Matter Physics (1 Unit)
Physical principles and techniques used in the study of molecular materials. Liquid crystals; polymers; floating monolayers; membranes; structured interfaces; self-assembly; complex and structured fluids; gels, colloids, and emulsions; DNA.

PHYSICS 436-0 Mesoscopic and Nanometer Scale Physics (1 Unit)
Selected topics related to quantum effects in mesoscopic systems. For example: quantum interference in disordered conductors, transport in semiconductor quantum dots, mesoscopic superconductors, and spin-polarized transport.

PHYSICS 440-0 Advanced Topics in Nuclear Physics (1 Unit)
Specialized lectures on current research topics.

PHYSICS 441-0 Statistical Methods for Physicists and Astronomers (1 Unit)
Data analysis in the modern age requires familiarity of many concepts and methods from statistics. This course provides an introduction to the basics as well as exposure to some of the most advanced techniques. The emphasis will be on practical problems from physics and astronomy, rather than on theory or on statistical methods from other fields. Prior knowledge of statistics is not required.

PHYSICS 442-0 Advanced Topics in Particle Physics (1 Unit)
Specialized lectures on current research topics in high-energy particle physics.

PHYSICS 445-1 General Relativity (1 Unit)
Review of special relativity and Newtonian gravity; Gravity as geometry of curved spacetime; Geodesics and conservation laws; Schwarzschild geometry; Gravitational collapse and black holes; Rotating black holes and the Kerr geometry; Linearized gravity and gravitational waves; Cosmological models for the expanding Universe.

PHYSICS 445-2 General Relativity (1 Unit)
First quarter: Review of special relativity and Newtonian gravity; Gravity as geometry of curved spacetime; Geodesics and conservation laws; Schwarzschild geometry; Tests of GR and the PPN formalism; Gravitational collapse and black holes; Rotating black holes and the Kerr geometry; Linearized gravity and gravitational waves; Cosmological models for the expanding Universe. Second quarter: Differential geometry, tensors, covariant derivatives; Riemann curvature and the field equation in vacuum; Energy-momentum tensor, the Einstein equation; Perturbation theory, gauge transformations; Emission of gravitational radiation; More advanced applications, as time permits, such as: relativistic stars, TOV equation and the Chandrasekhar limit, relativistic hydrodynamics; ADM formalism and numerical relativity; quantum mechanics in curved spacetime, inflationary cosmology.

PHYSICS 450-0 Advanced Topics in Condensed Matter (1 Unit)
Specialized lectures on current research topics.

PHYSICS 460-0 Advanced Topics in Statistical Physics (1 Unit)
Specialized lectures on current research topics.

PHYSICS 465-0 Advanced Topics in Nonlinear Dynamics (1 Unit)
Specialized lectures on current research topics in nonlinear dynamics.

PHYSICS 470-0 Introduction to Biological Physics: From Molecules to Cells (IBiS 410) (1 Unit)
Quantitative physics-based approach to molecular and cell biology, focused on developing an understanding of connections between biomolecule structure and dynamics, and behavior of cells. The course will also include review of topics from statistics of random variables and statistical data analysis relevant to biology and biophysics.

PHYSICS 480-0 Advanced Topics in Atomic, Molecular, and Optical Physics (1 Unit)
Specialized lectures on current research topics in atomic, molecular, and optical physics.

PHYSICS 499-0 Independent Study (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS May be repeated for credit. Permission of instructor and department required.

PHYSICS 519-0 Responsible Conduct of Research Training (0 Unit)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

### Plant Biology & Conservation (PBC)

PBC 401-0 Plant Evolution & Diversity Lab (1 Unit)
Modern systematics emphasizing application and major themes in the evolution of vascular plants.

PBC 402-0 Plant Community Ecology (1 Unit)
The purpose of this class is 1) to introduce students to the scope of the science of ecology at more complex levels of organization, and 2) to develop sophistication in understanding community and ecosystem ecology literature through the exploration of both classical and recent literature.

PBC 405-0 Ecosystem Ecology (1 Unit)
Concepts and principles of ecosystem ecology, with an emphasis on terrestrial ecosystems under the context of global change. Mass and energy flows through living and non-living ecosystem components as well as their environmental controls.

PBC 410-0 Plant Interaction with Biotic Environment (1 Unit)
This course explores interactions between plants and animals, including antagonistic ones (e.g., herbivory), mutualistic ones (e.g., pollination, seed dispersal, ant-plant associations), and interactions among multiple species and across trophic levels. Through survey of the primary literature, we will investigate the causes of the interactions and their consequences for individual organisms, populations, communities, and entire ecosystems. Finally, we will examine how these various
interactions are responding to global change, including habitat destruction and climate change.

PBC 415-0 Spring Flora (1 Unit)
This course takes a field-based approach to learning the process of identifying major components of the local flora in an evolutionary context. Understanding vegetative and reproductive structures of plants, and use of this knowledge to identify plants with taxonomic keys is emphasized. Ecological interactions, and related conservation issues are also covered.

PBC 418-0 Soils and the Environment: The Earth's Critical Zone (1 Unit)

PBC 420-0 Field Methods in Plant Conservation (1 Unit)
The science of plant conservation broadly encompasses the knowledge of many ecological field techniques. This course is designed to give students a real understanding of and hands-on experience in plant conservation practices with conservation practitioners in the greater Chicago area. Students will be exposed to a broad range of conservation issues, learn how they are being addressed, conduct relevant field projects, analyze the data, and interpret the results. Every other class meeting will be an all day trip to a field site. The alternating class meetings will deal with the analysis of the data collected. On field days, be sure to dress appropriately for the weather.

PBC 425-0 Molecular Ecology (1 Unit)
The aim of this course is to explore the relevance of Evolutionary theory and modern molecular lab techniques to Ecological Research. Ecology is the study of the distribution and abundance of living organisms and how they are affected by interactions with other organisms and their environment. Evolution has played an important role in determining the species, and a populations, origin, distribution and the intra and abiotic interactions they experience, and these factors will go on to affect the future evolutionary trajectory of that species or population. Hence in this course we will explore important evolutionary concepts in reference to ecological processes and biological concepts.

PBC 430-0 Conservation Genetics (1 Unit)
In this course we will learn how basic evolutionary and genetic principles inform the conservation and management of wildlife, game, and plant populations. We will read and discuss current research in the primary literature, examine case studies of current practices, and engage in group problem-solving and computer simulation exercises.

PBC 435-0 Quantitative Methods for Ecology & Conservation (1 Unit)
Methods for analyzing data sets in ecology and conservation biology will be taught in a computer lab setting. Students will also conduct research projects using original or publicly available data and results will be presented to the class in a professional, publication ready form.

PBC 450-0 Field and Laboratory Methods in Plant Biology and Conservation (2 Units)
This course is aimed to provide students with the knowledge, critical thinking, and practical skills to design, execute, and analyze plant biology and conservation research in order to help find solutions to real conservation problems. As this often requires the mastery of many skills across disciplines, the course is team taught and includes hands on training in topics such as experimental design, sampling methods, managing data, soil analyses, pollinator and breeding studies, DNA extraction, PCR, and DNA fingerprinting.

PBC 451-0 Critical Topics in Ecology and Conservation (1 Unit)
This course provides students with the conceptual and theoretical framework within the field of plant biology (especially ecology) and conservation. This is a seminar style class based on reading and discussion of works ranging from historical literature to recent studies including topics such as conservation policy, economics of conservation, climate change, invasive species, habitat fragmentation, and applied conservation case studies.

PBC 470-0 Special Topics in Plant Biology and Conservation (1 Unit)
This seminar-style course will focus on a wide range of rotating current topics in the field of conservation science and practice.

PBC 499-0 Independent Study (1-3 Units)
This is a required course for the master's degree in plant biology and conservation in which students will work with an instructor of their choice conducting independent literature, lab, or field research. Prerequisites: Permission of instructor.

PBC 590-0 Research (1-4 Units)
This course will allow students in our new PhD program to sign up for research credit once they have completed a set of core basic courses. Students will be working on their independent research projects while taking this course.

Political Science (POLI_SCI)

POLI_SCI 307-0 Deportation Law and Politics (1 Unit)
Analysis of deportation law and politics from colonial America through today. Requires two visits to Chicago immigration courts. 

POLI_SCI 310-0 Methods of Political Inference (1 Unit)
Methods for inferences based on data in political research. Research design and quantitative and qualitative methods of inference. Focuses on descriptive, statistical, and causal inference and the application of different methods to substantive problems.

POLI_SCI 320-0 The American Presidency (1 Unit)
Structural foundations and historical development of the American presidency; predominant scholarly theories of presidential power and leadership; contemporary issues and debates. Prerequisite: POLI_SCI 220-0 or equivalent.

POLI_SCI 323-0 Public Opinion and Voting Behavior (1 Unit)
Who votes and for whom. Social, psychological, economic, and political factors influencing election choices. Sources of opinions. Focus on American presidential elections with some comparative and nonpresidential material. Prerequisite: POLI_SCI 220-0 or equivalent.

POLI_SCI 324-0 Political Parties and Elections (1 Unit)
Role of political parties in a democratic society. Topics include nomination, national conventions, political funding, campaigns, party organization, and national, state, and local parties. Prerequisite: POLI_SCI 220-0 or equivalent.

POLI_SCI 325-0 Congress and the Legislative Process (1 Unit)
Organization of legislatures to make public policy; impact of constituents and political parties on legislative decision making; polarization; legislative-executive relations. Emphasis on the US Congress and contemporary politics. Prerequisite: POLI_SCI 220-0 or equivalent.

POLI_SCI 327-0 African American Politics (1 Unit)
Survey of black politics in the United States, including black’s relations with government, whites, political parties, public policy, and electoral politics. A different method to substantive problems.

POLI_SCI 328-0 Public Policy (1 Unit)
The role of government in regulating economic and social behavior; theories of public policy making; sources and effects of public policy.

**POLL_SCI 329-0** U.S. Environmental Politics (1 Unit)
Political problems associated with human impact on natural environment; pollution, natural resources, public lands, land use, energy, and population.

**POLL_SCI 331-0** Politics of the Supreme Court (1 Unit)
Operation of appellate courts, with emphasis on the US Supreme Court. Decision making by appellate courts and the development of public policy.
Prerequisite: POLL_SCI 220-0 or POLL_SCI 230-0.

**POLL_SCI 332-0** Constitutional Law I (1 Unit)
Introduction to interpretation of the US Constitution by the Supreme Court. Judicial review, federalism, congressional and executive authority, separation of powers. Taught with LEGAL_ST 332-0; may not receive credit for both courses.
Prerequisite: POLL_SCI 220-0 or POLL_SCI 230-0.

**POLL_SCI 333-0** Constitutional Law II: Civil and Political Rights (1 Unit)
Consideration of US Supreme Court decisions dealing with civil and political rights, including equality, freedom of speech and religion, and criminal procedures. LEGAL_ST 333-0 and POLL_SCI 333-0 are taught together; may not receive credit for both courses.
Prerequisite: POLL_SCI 220-0 or POLL_SCI 230-0.

**POLL_SCI 342-0** International Organizations (1 Unit)
Institutions that govern the interactions of states, including the WTO, UN, ICJ, and ICC; informal norms, such as international intervention, international criminal law, and sovereignty. POLL_SCI 342-0 and LEGAL_ST 342-0 are taught together; may not receive credit for both courses.
Prerequisite: POLL_SCI 240-0 or consent of instructor.

**POLL_SCI 345-0** National Security (1 Unit)
Basic issues in national security, focusing primarily on the United States. Topics include the nature of "national interest," major actors in national security policy making and military strategy, and the influence and role of the defense establishment.

**POLL_SCI 346-0** European Union in International Affairs (1 Unit)
Introduction to the institutions and policies of the European Union today.

**POLL_SCI 347-0** Ethics in International Relations (1 Unit)
Role of ethical considerations in international relations: where and when ethical questions are raised and by whom; causes and predictability of tensions between the ethics and self-interests of nations and political figures.

**POLL_SCI 353-0** Politics of Latin America (1 Unit)
Patterns of socioeconomic development and regime forms in Latin America. Interaction of internal and international economic and political structures and processes.

**POLL_SCI 354-0** Politics of Southeast Asia (1 Unit)
Political economy of selected Southeast Asian countries, 1945 to present. Important themes include oligarchy and human rights.

**POLL_SCI 355-0** Politics of China (1 Unit)
Chinese politics since 1949, focusing on social issues and state-society relations since 1989. Basic foundation for the non-specialist as well as preparation for advanced study.

**POLL_SCI 359-0** Politics of Africa (1 Unit)
Political structures and relations of cultural factors to political stability and change: development of modern political systems.

**POLL_SCI 361-0** Democratic Transitions (1 Unit)
Theories of the emergence and breakdown of democracy with a focus on cases from Europe, Latin America, Africa, and Asia. Note: students cannot receive credit for both POLL_SCI 361-0 (Evanston) and POLL_SCI 361-SA (study abroad).

**POLL_SCI 362-0** Politics of Europe (1 Unit)
Impact of historical development on contemporary institutions, political and political-economic institutions, interest groups and parties, policy making, and social and economic policy.

**POLL_SCI 364-0** U.S. Environmental Politics (1 Unit)
Introduction to the institutions and policies of the European Union today.

**POLL_SCI 390-0** Special Topics in Political Science (1 Unit)
Designed for investigation of topics of interest to students and faculty that are not covered by other course offerings. May be repeated for credit with change of topic.

**POLL_SCI 403-0** Introduction to Probability and Statistics (1 Unit)
Set theory, sample spaces, combinatorics, conditional probability, Bernoulli and binomial random variables and distributions. Some discussion of estimation and inference.

**POLL_SCI 405-0** Linear Models (1 Unit)
Theory and application of linear regression and extensions such as limited dependent variables. Consequences of violating the assumptions underlying the classical linear regression model.
Prerequisite: Knowledge of introductory econometrics.

**POLL_SCI 406-0** Quantitative Causal Inference (1 Unit)
Topics include maximum-likelihood estimation, time-series regression, simultaneous-equation models, and measurement models.
Prerequisite: POLL_SCI 405-0 or equivalent.

**POLL_SCI 407-0** Experimental Political Science (1 Unit)
Experiments are a central methodology in political science. The design, implementation, and analysis of experiments raise a variety of distinct epistemological and methodological challenges. This class will review the challenges to experimentation, discuss how to implement experiments, and survey prominent applications. The class will touch on recent methodological advances in experiments and ongoing debates about the reliability of experimental studies.

**POLL_SCI 408-0** Interpretive Methods in Political Science (1 Unit)
This seminar is intended for graduate students in political science and related fields who are interested in empirical research using interpretive methods. It examines a wide range of logics of research and argument and considers their utility for the study of politics.

**POLL_SCI 410-0** American Politics Field Seminar (1 Unit)
Introduction and review of major studies in American politics on such topics as the presidency, the Congress, the courts, interest groups, political parties, and voting behavior. A basic course for graduate students.

**POLL_SCI 411-0** Theories of American Political Institutions (1 Unit)
Exploration of historical and contemporary debates in the study of political institutions, with a focus on U.S. politics (both federal and
state legislatures). Includes theories of parties, Congress, President, bureaucracy, interest groups, and courts. Emphasis on key debates, theories, and evidence.

POLI_SCI 412-0 Political Participation (1 Unit)
Participation of the masses in various political systems; the functions these activities serve. Modes and distribution of activity, protest and other unconventional forms of action, relationship to social stratification, social-choice theories of participation, and effects of different modes and levels of participation.

POLI_SCI 413-0 Theories of Political Behavior (1 Unit)
Contrasting approaches to the study of voting, theories of the survey response, psychological theories of mental process, models of public opinion, dispositional explanations of behavior, political participation, and mathematical models of social interaction.

POLI_SCI 414-0 The Presidency (1 Unit)

POLI_SCI 417-0 Legislatures (1 Unit)
Structure and function of legislative bodies in political systems. Focus on the US Congress; comparison with state and foreign legislatures. Political representation, legislative-executive relations, explanation of legislative behavior, and legislative leadership.

POLI_SCI 418-0 American Political Parties (1 Unit)
Organizational structure of political parties and its consequences; the nature and redefinition of political party coalitions; conflict and consensus building within parties; changes within the parties and their effect on power distributions; parties in governmental decision making; party activists; and policy formation and its implications within the parties.

POLI_SCI 419-0 American Political Development (1 Unit)
The historical construction of politics in the U.S. Topics include liberalism and conservatism, state-building and party-building; industrialization and the welfare state; political traditions, regimes, and orders; electoral realignments; constitutional development; social movements; and racial politics. Historical-institutional themes of timing and sequence, critical junctures, path dependence, policy feedback, political entrepreneurship, and intercurrence.

POLI_SCI 423-0 American Social Policy in Comparative Perspective (1 Unit)
This course provides an introduction to American social policy, particularly policies designed to mitigate risk, poverty, and/or inequality. The emphasis of this course is not policy, but politics. Specifically, we will focus on understanding the contours of the American welfare state and the institutional, economic, demographic, and political factors contributing to and inhibiting its development. This course will present studies specifically of the U. S., but also will examine comparative studies of institutions, economic systems, public opinion, and other factors to provide context.

POLI_SCI 424-0 Public Opinion, the Media, and Democracy (1 Unit)
This course is concerned with public opinion, the mass media, and the role of the public in making U.S. foreign and domestic policy. Topics include the micro foundations of public opinion (especially policy preferences), the influence of public opinion on policy, leadership or manipulation of opinion, and the quality of political information made available to the public through the media, including the systematic biases or deficiencies.

POLI_SCI 440-0 International Relations Theory (1 Unit)
Contemporary international relations theory. Basic concepts on the philosophy of social science and substantive theories of international relations, including neorealism, neoliberalism, marxism, and constructivism.

POLI_SCI 441-0 International Political Economy (1 Unit)
Assessment of the relative importance of systemic and domestic factors in the evolution of international economic relations, particularly among advanced industrialized democracies; the structure of dynamics of those relations.

POLI_SCI 442-0 International Organization (1 Unit)
Introduction to theories about the origin and role of international institutions in world politics. Why do states cooperate? Implications for democratic accountability and political legitimacy.

POLI_SCI 443-0 International Law and International Politics (1 Unit)
This seminar on international law builds on interdisciplinary approaches. It examines the social construction of norms in international affairs, legitimacy and fairness in shaping perceptions and behavior, and how institutions of international law shape international political processes and state behavior.

POLI_SCI 445-0 International Security (1 Unit)
Introduction to theories about the origin and role of international institutions in world politics. Issues include: cooperation, covenants, agreements, norms, democratic accountability, and political legitimacy.

POLI_SCI 447-0 Critical Studies in World Politics (1 Unit)
Scholarship on world politics in the Frankfurt School, Gramscian, and postmodern traditions.

POLI_SCI 450-0 Contemporary Theory and Research in Comparative Politics (1 Unit)
Major contemporary theoretical and methodological approaches such as society-centered, state-centered, political-institutional, political-cultural, and process-centered theoretical approaches; cross-national statistical and comparative-historical methodological approaches.

POLI_SCI 451-0 Comparative Political Economy of Developing Countries (1 Unit)
Examines political explanations for the divergence in economic performance among developing countries. Topics include the developmental state, collective action, property rights, and democracy.

POLI_SCI 452-0 Democratization (1 Unit)
The interrelationships between socioeconomic structures and democracy, the importance of political leadership, the historic relationship between capitalism and democracy, and contemporary tensions between market reform and democratization.

POLI_SCI 453-0 Modern Africa (1 Unit)
Interdisciplinary survey of current conditions in Africa; the place of Africa in the modern world.

POLI_SCI 454-0 Social Movements and Mobilization (1 Unit)
This graduate-level seminar explores the political conditions and processes shaping social and political mobilization, examining major theories from the fields of sociology and political science about social movements: collective challenges to authority that aim to change society or institute structural changes in an existing state or states.

POLI_SCI 455-0 Politics of Latin America (1 Unit)
This course provides an advanced introduction to the field of Latin American politics. The material is designed to familiarize students with both the substantive areas and the different theoretical and methodological orientations that characterize work in comparative politics on Latin America. The course assumes no prior knowledge of Latin America and is appropriate for graduate students who work mainly on other parts of the world.
POLI_SCI 458-0 Political Institutions (1 Unit)
The new institutionalism is one of the most important recent advances in political science. This course surveys the main varieties of institutionalism - historical, rational choice, sociological - focusing on their main methods and major findings.

POLI_SCI 459-0 Comparative Political Parties (1 Unit)
Theory and methods of studying political parties in different societies; roles of parties in government; effects on public policy; interrelation of parties and electoral systems; types of party systems; environmental change and party change.

POLI_SCI 460-0 Comparative Politics Proseminar II (1 Unit)
Survey of major topics in comparative politics. Contemporary state of the subfield, its evolution, and emerging research questions and controversies. Themes include institutions, identities, the state, regimes, inequality.

POLI_SCI 461-0 Ancient and Medieval Political Thought (1 Unit)
Close reading of Greek sources with attention to literary, cultural and historical context and problems of translation. Texts include works in history, philosophy oratory, drama (e.g., Aristophanes, Thucydides, Plato, Aristotle). May be repeated for credit with different texts.

POLI_SCI 462-0 Early Modern Political Thought (1 Unit)
Close reading of late Medieval and Renaissance to early Enlightenment sources. Topics: the separation of church and state; social division and political unity; politics between anthropology and cosmology; the rise of individualism; the state as work of art. may be repeated for credit with different topics and authors.

POLI_SCI 463-0 Late Modern Political Thought (1 Unit)

POLI_SCI 464-0 Contemporary Political Thought (1 Unit)

POLI_SCI 465-0 American Political Thought (1 Unit)
An advanced introduction to the development of American political thought in the US, from the Revolutionaries to the Pragmatists. Seminar will attempt to convey the spirit and substance of the debates that have identified American political thought at different times, especially over the revolution against British subjection, the founding of a compound republic, federalism and the relationship between the states, the representation of citizens, the varieties of individualism and nationalism, the socialist utopia, the pragmatist vision, and the character of State and Nation. The seminar will attempt some thematic organization by attending to citizens and the state(s), as these are discussed in our primary texts. The seminar will also take note of the different kinds of texts of theorizing: from systematic treatises to letters, speeches, pamphlets and a novel.

POLI_SCI 468-0 Problems in Democratic Theory (1 Unit)
Consideration of issues such as whether democracy presupposes a demos that is socially unified. What are democracy's prospects in an age of globalization and transnationalism?.

POLI_SCI 469-0 Special Topics in Knowledge & Politics (1 Unit)
Examination of the crisis - or promise - of meaning that results from the multitude of ways in which political and linguistic theorists have responded to the challenge to think about language in non-referential terms.

POLI_SCI 471-0 Game Theory: Math Models of Individual Political Behavior (1 Unit)
An introduction to game theory. Topics covered include individual decision-making under uncertainty; normal and extensive form games; games of incomplete information; repeated games. Applications to voting theory, collective action and institutional choice.

POLI_SCI 483-0 American Political Behavior Graduate Workshop (1 Unit)
Key debates and developments in research on American Political Behavior; the development, presentation and critique of student-generated original research.

POLI_SCI 484-0 Comparative-Historical Social Science Workshop (1 Unit)
This course is an interdisciplinary seminar designed for graduate students interested in comparative and historical work, broadly defined. Some of the work is more comparative and some is more historical. The workshop includes presentations of new work by Northwestern graduate students, Northwestern faculty, and leading outside scholars in the field of comparative-historical analysis.

POLI_SCI 486-0 Advanced Topics in Middle East Politics (1 Unit)
Middle East Politics Advanced seminar on topics including state formation, regimes, political economy, political culture, political institutions, identity, social movements, and religion in politics. From late Ottoman era through 2011 uprisings.

POLI_SCI 490-0 Special Topics in Political Science (1 Unit)
Investigation of topics of current interest to students and faculty not covered by other offerings.

POLI_SCI 495-0 Qualitative Methods (1 Unit)
This seminar provides a broad introduction to research design and qualitative methods. The first part of the course covers foundational issues, including conceptualization, measurement, and causality in a qualitative context. Part II introduces students to various approaches and techniques including case studies, process tracing, archival, ethnographic, and interview methods, considering the utility and tradeoffs of each.

POLI_SCI 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS. Permission of instructor and department required. May be repeated for credit.

POLI_SCI 519-0 Responsible Conduct of Research Training (0 Unit)

POLI_SCI 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS. Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Portuguese (PORT)

PORT 380-0 Contemporary Brazil: Literature and Film (1 Unit)
Study of the literature and film produced in Brazil during the 21st century. Focus on narrative forms, genres, and sociocultural issues.

PORT 396-0 Topics in Lusophone Cultures (1 Unit)
Aspects of the literatures and cultures of Brazil, Portugal, and Lusophone Africa (Mozambique, Angola, Cape Verde, São Tomé and Príncipe, Guinea-Bissau). Possible topics include Brazilian modernism, Lusophone African literature and film, race and sexuality in Brazilian literature, travel narrative, literature and ethnography, the Portuguese novel, nation and nationalism. May be repeated for credit with different topic.

Predictive Science and Engineering (PSED)

PSED 510-1 Predictive Science & Engineering Design Cluster Seminar (0 Unit)
PSYCH 322-1 Selected Topics in Neuroscience and Psychophysiology (1 Unit)
Intermediate principles of neuroscience; neurophysiology, neuropharmacology, neuroanatomy, and electrophysiological substrates of psychological processes. Prerequisites: PSYCH 110-0; 1 biological sciences course. *Natural Sciences Distro Area*

PSYCH 322-2 Selected Topics in Neuroscience and Psychophysiology (1 Unit)
Applied psychophysiology; brain activity coding of cognitive events, biofeedback, opiate pain control. Prerequisite: PSYCH 322-1 or equivalent; PSYCH 205-0 recommended. *Natural Sciences Distro Area*

PSYCH 324-0 Perception (1 Unit)
Human perception, particularly vision but also hearing, taste, smell, and touch. Biological foundations, development, and disorders of perception. The senses in everyday life. Prerequisite: PSYCH 110-0. *Natural Sciences Distro Area*

PSYCH 333-0 Psychology of Thinking (1 Unit)
Research methods and recent experimental findings for types of human thinking. Students conduct original research. Prerequisite: PSYCH 228-0. *Social Behavioral Sciences Distro Area*

PSYCH 340-0 Psychology and Law (1 Unit)
Examines the application of psychology to law, including topics such as the insanity defense, criminal profiling, eyewitness testimony, and interrogation. Taught with LEGAL_ST 350-0; may not receive credit for both courses. Prerequisite: PSYCH 110-0. *Social Behavioral Sciences Distro Area*

PSYCH 350-0 Special Topics in Psychology (1 Unit)
Topic to be announced. Prerequisites vary. May be repeated for credit with different topic. *Social Behavioral Sciences Distro Area*

PSYCH 373-0 Decision Making (1 Unit)
Human decision making from both descriptive and prescriptive perspectives. Theories and models of decision making applied to a variety of contexts. Prerequisites: PSYCH 205-0, PSYCH 228-0. *Social Behavioral Sciences Distro Area*

PSYCH 378-0 Images of Cognition (1 Unit)
Study of brain processes underlying cognition. Analysis of brain structure and function. Introduction to imaging techniques including fMRI, PET, and ERP. Prerequisites: PSYCH 205-0; a course in cognition and/or neuroscience (e.g., PSYCH 221-0, PSYCH 228-0, PSYCH 322-1, PSYCH 328-0; COG_SCI 210-0) or consent of instructor. *Interdisciplinary Distro - See Rules*
This practicum will cover the theory, history, empirical evidence, and clinical techniques on the assessment and treatment of anxiety disorders, emphasizing cognitive-behavioral approaches.

**PSYCH 413-3 Anxiety: Assessment and Treatment (1 Unit)**
This practicum will cover the theory, history, empirical evidence, and clinical techniques on the assessment and treatment of anxiety disorders, emphasizing cognitive-behavioral approaches.

**PSYCH 414-1 Depression: Assessment and Treatment (1 Unit)**
This practicum will cover the theory, history, empirical evidence, and clinical techniques on the assessment and treatment of anxiety disorders, emphasizing cognitive-behavioral approaches.

**PSYCH 414-2 Depression: Assessment and Treatment (1 Unit)**

**PSYCH 414-3 Depression: Assessment and Treatment (1 Unit)**

**PSYCH 415-1 Treatment Practicum: Family and Systems Approach (1 Unit)**

**PSYCH 415-2 Treatment Practicum: Family and Systems Approach (1 Unit)**

**PSYCH 415-3 Treatment Practicum: Family and Systems Approach (1 Unit)**

**PSYCH 416-1 Treatment Practicum: DBT (1 Unit)**
Strategies and tactics of dialectical behavior therapy for effectively treating complex, multi-problem, difficult-to-treat populations.

**PSYCH 416-2 Treatment Practicum: DBT (1 Unit)**
Strategies and tactics of dialectical behavior therapy for effectively treating complex, multi-problem, difficult-to-treat populations.

**PSYCH 416-3 Treatment Practicum: DBT (1 Unit)**
Strategies and tactics of dialectical behavior therapy for effectively treating complex, multi-problem, difficult-to-treat populations.

**PSYCH 420-0 History, Ethics, Diversity, and Consultation in Clinical Psychology (1 Unit)**
This course considers many of the ethical and diversity issues that clinical scientists and therapists encounter; it also considers the historical bases of current psychological research and practice. Two-quarter sequence.

**Prerequisites:** Permission of instructor.

**PSYCH 421-1 Psychopathology (1 Unit)**
Research and theories on the origins of various forms of psychopathology. Topics include schizophrenia, addictive disorders, psychopathy, personality disorders, eating disorders, psychosexual disorders, depression, and anxiety disorders. Also, issues regarding classification of psychiatric disorders. Two-quarter sequence.

**PSYCH 421-2 Psychopathology (1 Unit)**
Research and theories on the origins of various forms of psychopathology. Topics include schizophrenia, addictive disorders, psychopathy, personality disorders, eating disorders, psychosexual disorders, depression, and anxiety disorders. Also, issues regarding classification of psychiatric disorders. Two-quarter sequence.

**PSYCH 422-0 Child Psychopathology (1 Unit)**
Diagnosis and treatment of various conditions of childhood psychopathology: learning disabilities, phobias, autism, and aggression.

**PSYCH 423-0 Professional Issues in Psychology (1 Unit)**
Survey of ethical, professional, and policy issues in clinical psychology.

**PSYCH 424-0 Behavioral and Neural Basis of Visual Perception (1 Unit)**
Reviews current understanding of the encoding of visual information on the basis of behavioral, neurophysiological, and neuropsychological evidence.

**Prerequisites:** Permission of instructor.

**PSYCH 425-0 Improving Methods and Practices in Psychological Science: The Replication Crisis and Beyond (1 Unit)**
This course will examine current controversies and new developments in research methods in psychology. The goal of the course is to learn to think critically about how psychological science is conducted and how conclusions are drawn. We will cover both methodological and statistical issues that affect the validity of research in psychology, with a scope that will cover the broad topical range of psychological science. We will discuss the research process from designing a study to how a study gets published. We will also discuss the recent controversy in psychology about the replicability of scientific results.

**PSYCH 428-0 Overview of Health Psychology (1 Unit)**
Overview of research, theories, and methods in health psychology, emphasizing links between the social world and biology.

**PSYCH 430-0 Relationships (1 Unit)**

**PSYCH 434-0 Research Methods in Clinical Psychology (1 Unit)**
Conceptual and methodological issues in research in psychopathology and psychotherapy.

**PSYCH 440-0 Self-Regulation (1 Unit)**
This seminar-based course provides an overview of the social psychological literature on self-regulation. It covers the major theoretical orientations and places a particular emphasis on empirical evidence.

**PSYCH 446-0 Memory & Cognit (1 Unit)**
Theories of encoding and retrieval processes, semantic memory, automatic and strategic processes, and memory structure of text.

**PSYCH 450-0 Fundamentals of Statistics (1 Unit)**
Probability, decision rules, and tests of significance, including chi square, t, and F.

**PSYCH 451-1 Statistics in Experimental Design (1 Unit)**
Design and analysis of experiments. Emphasis on analysis of variance techniques.

**PSYCH 453-0 Linear Models: Correlation & Regression (1 Unit)**
Measurement theories and their implications for the quantification of psychological constructs.

**PSYCH 455-0 Teaching of Psychology (1 Unit)**
This course is designed to help prepare graduate students in psychology for the role of classroom instructor. Topics that will be discussed include course design, lecturing, using demonstrations, ethics, and teaching writing in psychology.

**PSYCH 460-0 Special Topics in Cognition (1 Unit)**
Current research and theory in cognitive psychology. May be repeated for credit with change of topic.

**PSYCH 461-0 Reasoning and Representation (1 Unit)**
Current theories of reasoning in cognitive science; mental steps in solving problems requiring inductive or deductive inferences. Covers relevant background in logic and artificial intelligence and empirical results on reasoning.

**Prerequisites:** One course in either cognitive psychology, logic, or artificial intelligence.

**PSYCH 462-0 Cognitive Development (1 Unit)**
Cognitive development in infancy, childhood, and adolescence. Focus on theoretical explanations for cognitive change and development in core domains, including language, space, number, time, and social relations.

**PSYCH 466-0 Analog and Similarity (1 Unit)**
Psychology of comparison, including theories of similarity, analogy and metaphor in psychology and artificial intelligence; processes of transfer,
comparison in decision making; analogy in mental models and folk theories; and development of analogy and similarity.

PSYCH 467-0 Culture, Language, and Cognition (1 Unit)
Survey of theory, data, and methods in cultural research on language and cognition. Focus is on empirical research and its relation to cognitive psychology.

PSYCH 470-0 Topics in Brain, Behavior, and Cognition (1 Unit)
Survey of contemporary research in cognitive neuroscience. Covers investigations of memory, perception, and other aspects of cognition using many methodologies, including neuropsychology and neuroimaging.

PSYCH 471-0 Cognitive Neuroscience (1 Unit)
Overview of the conceptual and practical aspects of experimental research in social psychology, including design, questionnaire development, validity and reliability, and ethical issues.

PSYCH 481-0 Theories in Social Psychology (1 Unit)
Introductory overview of social psychology for graduate students, with a focus on recent and classic theories and their empirical support.

PSYCH 482-0 Research Methods in Social Psychology (1 Unit)
Survey of theory, data, and methods in cultural research on language and cognition. Focus is on empirical research and its relation to cognitive psychology.

PSYCH 483-0 Social Cognition (1 Unit)
Comprehensive survey of research addressing social aspects of perception, memory, language, and judgment and their role in social behavior and outcomes.

PSYCH 485-0 Psychology of Attitudes (1 Unit)
Survey of social psychological theory and attitudes. Considers attitude measurement, attitude structure, attitudes as predictors of behavior, and attitude change. Prerequisites: Permission of instructor.

PSYCH 486-0 Stereotyping and Prejudice (1 Unit)
Analysis of the psychological causes and consequences of stereotyping and prejudices with a focus on recent developments in the field of social psychology.

PSYCH 488-0 Theories of social and emotional development (1 Unit)
This graduate-level seminar closely examines theories and research on social and emotional development. Particular attention is given to theories and research that address the roles of culture, context, and marginalization. The course adopts an ecological perspective, examining how multiple, intersecting levels of micro and macro contexts (parents, peers, schools, media, culture, stereotypes) shape social and emotional development and its associations with psychosocial adjustment, academic success, and health.

PSYCH 489-0 Topics in Social Psychology (1 Unit)
Research and theory of current interest. Topics vary. May be repeated for credit with change of topic.

PSYCH 490-0 Topics in Clinical/Personality Psychology (1 Unit)
Development of cognitive structures and processes, including learning, memory, reasoning, language, and conceptual systems. Advanced level.

PSYCH 492-0 Advanced Topics in Cognitive Development (1 Unit)
The nature and functions of theory in psychology. Major theoretical approaches to personality: dynamic, phenomenological, trait, social-psychological, sociological, and behavioral.

PSYCH 495-1 Psychological Assessment (1 Unit)
First Quarter: Introduction to assessment, interviewing, mental status exam, DSM-III, and objective personality test (MMPI). Second Quarter: Intellectual/neuropsychological assessment, including intellectual and achievement tests and report writing. Third Quarter: Projective assessment, including Rorschach, TAT, miscellaneous projective techniques, and report writing.

PSYCH 496-1 Contemporary Psychotherapy (1 Unit)
First Quarter: Contemporary approaches to individual psychotherapy. Second Quarter: Contemporary approaches to group psychotherapy and the treatment of disturbed marital and family relationships. Third Quarter: Minipracticum.

PSYCH 497-0 Special Topics in Clinical Psychology (1 Unit)
Research and theory in clinical psychology. May be repeated for credit with change of topic.

PSYCH 499-0 Independent Study (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

PSYCH 519-0 Responsible Conduct of Research Training (0 Unit)
May be repeated for credit.

PSYCH 590-0 Research (1-3 Units)
May be repeated for credit.

Public Health (PUB_HLTH)

PUB_HLTH 301-0 Behavior, Society & Health (1 Unit)
The course analyzes the interplay of social structure, technology, culture and demography on patterns of health, illness and health behavior. The course focuses on the application of theories of behavioral change for solving health and public health problems, including stages of change, relapse prevention, social advertising and social marketing methods for use in primary care and community settings.

PUB_HLTH 302-0 Introduction to Biostatistics (1 Unit)
The course focuses on descriptive statistics, principles of exploratory data analysis, basic probability, hypothesis testing, correlation, simple linear regression, and the basics of the analysis of variance. All examples are directed towards application of these methods in the medical and health fields.

PUB_HLTH 303-0 Environmental Health Sciences (1 Unit)
The course offers a broad background introduction to the analysis of the health consequences of exposure to air, weather, food, the workplace and other special environments potentially contaminated by biologic, chemical and physical agents.

PUB_HLTH 304-0 Introduction to Epidemiology (1 Unit)
This course introduces the science of epidemiology and its uses, including measures of disease occurrence, common sources and types of data, important study designs and sources of error in epidemiologic studies.

PUB_HLTH 305-0 Programming for Statistical Analysis (1 Unit)
This an introductory course to programming for statistical analysis using SAS. Topics include data management, descriptive statistics, tests of association and reports.

PUB_HLTH 310-0 Foundations of Public Health (0 Unit)
This three-quarter sequence is required for all MPH students during the first year of enrollment. Students earn one unit of credit, awarded in the spring quarter. The “Foundations” course focuses on knowledge acquisition and skill development essential for public health practice. Foundations uses the case-based teaching method, and covers the Council on Education for Public Health (CEPH)’s 12 required knowledge objectives for MPH education.

PUB_HLTH 311-0 Foundations of Public Health (0 Unit)
This three-quarter sequence is required for all MPH students during the first year of enrollment. Students earn one unit of credit, awarded
in the spring quarter. The "Foundations" course focuses on knowledge acquisition and skill development essential for public health practice. Foundations uses the case-based teaching method, and covers the Council on Education for Public Health (CEPH)'s 12 required knowledge objectives for MPH education.

**PUB_HLTH 312-0 Foundations of Public Health (1 Unit)**
This three-quarter sequence is required for all MPH students during the first year of enrollment. Students earn one unit of credit, awarded in the spring quarter. The "Foundations" course focuses on knowledge acquisition and skill development essential for public health practice. Foundations uses the case-based teaching method, and covers the Council on Education for Public Health (CEPH)'s 12 required knowledge objectives for MPH education.

**PUB_HLTH 313-0 Topics in Public Health (0.5 Unit)**
This variable topics course addresses important current issues in public health.

**PUB_HLTH 314-0 Topics in Public Health (0.5 Unit)**
This variable topics course addresses important current issues in public health.

**PUB_HLTH 315-0 Topics in Public Health (1 Unit)**
This variable topics course addresses important current issues in public health.

**PUB_HLTH 316-0 Topics in Public Health (1 Unit)**
This variable topics course addresses important current issues in public health.

**PUB_HLTH 317-0 Seminar in Community Health Research (0 Unit)**
The Seminar in Community Health Research is a weekly one-hour seminar that is required for all MPH students in the Community Health Research concentration. The student will earn one unit of credit for each year, awarded in the fall quarter. The seminar will provide students with an overview of methods, approaches and research design considerations that are relevant to design, implementation and evaluation of community health research. Many of the topics covered in this course will be discussed in greater detail in other core and elective courses within the MPH program. An emphasis will be placed on providing case examples to help illustrate key points. These case examples will highlight community health research conducted by Northwestern faculty as well as research conducted at other universities.

**PUB_HLTH 318-0 Seminar in Community Health Research II (0 Unit)**
The Seminar in Community Health Research is a weekly one-hour seminar that is required for all MPH students in the Community Health Research concentration. The student will earn one unit of credit for each year, awarded in the fall quarter. The seminar will provide students with an overview of methods, approaches and research design considerations that are relevant to design, implementation and evaluation of community health research. Many of the topics covered in this course will be discussed in greater detail in other core and elective courses within the MPH program. An emphasis will be placed on providing case examples to help illustrate key points. These case examples will highlight community health research conducted by Northwestern faculty as well as research conducted at other universities.

**PUB_HLTH 319-0 Seminar in Community Health Research III (1 Unit)**
The Seminar in Community Health Research is a weekly one-hour seminar that is required for all MPH students in the Community Health Research concentration. The student will earn one unit of credit for each year, awarded in the fall quarter. The seminar will provide students with an overview of methods, approaches and research design considerations that are relevant to design, implementation and evaluation of community health research. Many of the topics covered in this course will be discussed in greater detail in other core and elective courses within the MPH program. An emphasis will be placed on providing case examples to help illustrate key points. These case examples will highlight community health research conducted by Northwestern faculty as well as research conducted at other universities.

**PUB_HLTH 320-0 Community Engaged Research (1 Unit)**
This introductory course in community health considers the basic elements that determine health and asks difficult questions about why the richest and most powerful country in world history is so unhealthy? Discussion will focus on differences in communities, community health assessments, principles for effective collaboration with communities and introduction to community health research.

**PUB_HLTH 323-0 Health Equity (1 Unit)**
This course provides an overview of social, economic and political inequities in the United States and their impact on the health of the poor, uninsured, elderly, racial and ethnic minorities, migrants, gendered and sexual groups, rural residents, people with mental and physical disabilities and other vulnerable and socially disadvantaged populations. Past and current policies and trends in health /medical care programs and services at the local and national levels will be discussed. Students will examine social science concepts and theoretical frameworks that will expand their knowledge and skills and empower them to become agents of social change using public health models to impact individuals, families, communities and institutions. Class topics and discussions will be directed on: social and income inequalities; access (or lack of) to healthcare, including preventive services and other social resources; roles of government and the legislative process; quality care; legal and ethical issues; among others. Throughout the course, discussions will center on the social determinants of health - neighborhood environments and strategies toward short and long term solutions in the elimination of health disparities and achieving health equity. Discussion about the Patient Protection and Affordable Care Act and recent Supreme Court rulings will also be integrated into many of the discussions.

**PUB_HLTH 330-0 Global Tobacco: Control and Prevention (1 Unit)**
The purpose of the course is to provide students with information on the health problems associated with tobacco use across the lifespan; the consequences of second- and third-hand smoke; new and promising clinical, public health and legal strategies for both prevention and cessation; and international perspectives on tobacco control. Special emphasis will be directed at tobacco use and prevention among vulnerable populations, including youth, minorities and the poor.

**PUB_HLTH 335-0 Dual Degree Seminar: Topics in Public Health for the Physical Therapist (0.5 Unit)**
The Topics in Public Health for the Physical Therapist seminar course sequence prepares the physical therapist/public health professional by explicitly linking and integrating physical therapy practice and public health practice. The course emphasis is to foster awareness of opportunities for the physical therapist/public health professional through discussion and analysis of public health practice and physical therapy practice. This course provides students the opportunity to interact with faculty on topics that integrate physical therapy and public health practice and policy. Goals of this course are to discuss the intersection of population health and clinical practice and the application of core skills needed for success in a physical therapist-public health career. Prerequisite: Only students in the DPT-MPH degree program are eligible to take this course.

**PUB_HLTH 387-0 Seminar in Global Health I (0 Unit)**
The Seminar in Global Health is a weekly one-hour three-quarter (Fall, Winter, Spring) seminar that is required for all MPH students in the Global Health concentration. The seminar will provide students with an overview
of the concentration, the interdisciplinary breadth of coursework, and the field and culminating experiences. The seminar will provide opportunities for critical analysis and dialogue on major global health issues. Many of the topics covered in this course will be discussed in greater detail in other core and elective courses within the MPH program and Global Health Concentration. An emphasis will be placed on providing case examples to help illustrate key points. These case examples will highlight global health research and practice. All three courses (PUB_HLTH 387-0, PUB_HLTH 388-0, PUB_HLTH 389-0) must be successfully completed in order to earn 1 credit at the end of spring quarter.

**PUB_HLTH 388-0 Seminar in Global Health II (0 Unit)**
The Seminar in Global Health is a weekly one-hour three-quarter (Fall, Winter, Spring) seminar that is required for all MPH students in the Global Health concentration. The seminar will provide students with an overview of the concentration, the interdisciplinary breadth of coursework, and the field and culminating experiences. The seminar will provide opportunities for critical analysis and dialogue on major global health issues. Many of the topics covered in this course will be discussed in greater detail in other core and elective courses within the MPH program and Global Health Concentration. An emphasis will be placed on providing case examples to help illustrate key points. These case examples will highlight global health research and practice. All three courses (PUB_HLTH 387-0, PUB_HLTH 388-0, PUB_HLTH 389-0) must be successfully completed in order to earn 1 credit at the end of Spring quarter.

**PUB_HLTH 389-0 Seminar in Global Health III (1 Unit)**
The Seminar in Global Health is a weekly one-hour three-quarter (Fall, Winter, Spring) seminar that is required for all MPH students in the Global Health concentration. The seminar will provide students with an overview of the concentration, the interdisciplinary breadth of coursework, and the field and culminating experiences. The seminar will provide opportunities for critical analysis and dialogue on major global health issues. Many of the topics covered in this course will be discussed in greater detail in other core and elective courses within the MPH program and Global Health Concentration. An emphasis will be placed on providing case examples to help illustrate key points. These case examples will highlight global health research and practice. All three courses (PUB_HLTH 387-0, PUB_HLTH 388-0, PUB_HLTH 389-0) must be successfully completed in order to earn 1 credit at the end of Spring quarter.

**PUB_HLTH 390-0 International Public Health I (1 Unit)**
Introduction to International Public Health will orient students to the biological, socio-cultural and economic influences on population-level variation in health and well-being. The continuum between health and illness will be explored, focusing on both the proximate and distal determinants of variation in health and well-being. Students will learn about key players in international health - the multilateral and bilateral donor communities, Ministries of Health, UN agencies, foundations, NGOs - and understand important shifts in donor policies towards healthcare delivery. They will be introduced to the major health problems currently affecting the developing world and alerted to the importance of employing a population-based vs. a purely clinical approach to solving these health problems.

**PUB_HLTH 391-0 Global Health Care Service Delivery (1 Unit)**
The course will engage students in an analysis of case studies that describe interventions to improve healthcare delivery in resource-limited settings. The cases capture various programmatic, organizational and policy-related innovations related to care delivery. Classroom discussions of these case studies will help illuminate principles and frameworks for the design of effective global health interventions. Through a focus on HIV, TB, malaria and other health conditions, these cases will allow students to carefully consider the question of how epidemiology, pathophysiology, culture, economy and politics inform the design and performance of global health programs.

**PUB_HLTH 393-0 Introduction to Health and Human Rights (1 Unit)**
This course, which is open to Public Health, Law and Kellogg students, examines the intersection of health and human rights at the global and national levels, in theory and in practice. Readings and discussion will focus on the following topics: the complex relationship between health and human rights; the right to health; global activism and litigation to promote health and human rights; the movement for access to medicines; sexual and reproductive health rights; and health systems in the United States. Students will work in interdisciplinary teams on a health assessment and intervention known as the Northwestern Access to Health Project. Headed by Professor Brian Citro, with assistance from Health and Human Rights Fellow Elise R. Meyer, the Access to Health Project seeks to leverage academic and community partnerships to maximize access to health in communities in the developing world and the United States.

**PUB_HLTH 410-0 Field Experience in Public Health (0 Unit)**
An approved field placement in a public health setting. Prerequisite: permission of instructor.

**PUB_HLTH 411-0 Assessment, Planning & Evaluation in Community Health (1 Unit)**
Assessment, Planning and Evaluation are three core features of community health research. The objective of this course is to provide an overview of the fundamental and basic skills needed for conducting research with community partners related to health assessments, program planning and evaluation of public health programs. We will focus on efforts needed in working with community partners and research methodologies recommended for effectively and efficiently conducting research without interrupting the flow of community organizations. You will have an opportunity to talk with representatives from community organizations and to apply your learning to an actual community setting.

**PUB_HLTH 412-0 Infection Disease Epidemiology and Prevention (1 Unit)**
This course focuses on the public health tools for the surveillance, identification, control and prevention of selected infectious diseases of public health importance. Special emphasis will be focused on outbreak investigations because they provide a unique opportunity to apply many principles of public health practice, including use and interpretation of surveillance data, risk factor analysis and implementation and assessment of control measures.

**PUB_HLTH 414-0 Injury and Violence Prevention (1 Unit)**
This course examines injury as a public health problem and explores research methods, study design, risk factors and prevention strategies applied to problem of injuries. This general framework will be applied to the study of specific injury mechanisms.

**PUB_HLTH 415-0 Disease Prevention and Health Promotion: Principles and Application (1 Unit)**
This course explores the value of and barriers to disease prevention and health promotion (DP/HP), factors that influence personal health decisions, preventive interventions directed at individuals (clinical settings) and populations (community settings), strategies for using population health principles to integrate DP/HP into routine medical and Public Health practice and the organization of federal agencies that fund DP/HP activities.

**PUB_HLTH 416-0 Program Evaluation (1 Unit)**
This course will provide students with a comprehensive theoretical, methodological and ethical foundation for conducting public health program evaluation. Students will experience the practice aspects of
evaluation including communicating and negotiating with stakeholders, conducting an evaluability assessment, developing logic models and evaluation questions, identifying appropriate data collection methods, gathering reliable and valid evaluation data that are appropriate to the selected design and analysis methods, analyzing data, reporting evaluation results, and ensuring evaluation use. The instructor will facilitate a learning and skill-building environment, drawing on personal experiences and the expertise of others in the field.

**PUB_HLTH 417-0 Public Health Law: Promoting Healthy Youth Development (1 Unit)**
This course examines the application of law to critical Public Health issues affecting children and youth, including the constitutional and statutory foundation of Public Health law, how legislative and regulatory decisions must negotiate the balance between individual rights and public good and the principles of parens patriae and state police powers. Case studies will illustrate the basis of Public Health jurisprudence at the national level.

**PUB_HLTH 418-0 Applied Practice Experience I (0 Unit)**
The Applied Practice Experience (APEx) is a two course sequence, PH 418 and PH 419. Students complete this course while working at a public health service organization or faculty-supervised public health project. Students examine real-world aspects of public health practice through scholarly literature, community-based experiential learning, peer coaching, and skill-building modules.

**PUB_HLTH 419-0 Applied Practice Experience II (0 Unit)**
In the APEx II, students gain real-word public health practice experience by working with public health leaders to develop public health products that serve diverse communities in domestic or international settings. All MPH students are required to complete the practice experience. Prerequisite: PUB_HLTH 418-0.

**PUB_HLTH 420-0 Introduction to US Health Care System (1 Unit)**
Course Aims: Be able to state and explain the structure, key facts and important issues pertaining to the U.S. health system. Be able to research topics for further study by becoming familiar with the relevant literature and be able to analyze problems in this sector by understanding applicable frameworks.

**PUB_HLTH 421-0 Intermediate Biostatistics (1 Unit)**
Intermediate Biostatistics builds upon the material learned in Introduction to Biostatistics. Specifically, the course will focus on single-outcome, multiple-predictor methods: multiple linear regression for continuous outcomes, logistic regression for binary outcomes, and the Cox proportional hazards model for time-to-event outcomes. Degree-seeking students must take either this course or PUB_HLTH 422-0.

**PUB_HLTH 422-0 Intermediate Epidemiology (1 Unit)**
This course covers epidemiologic methods used in observational epidemiologic studies including the design, conduct and interpretation of observational studies in human populations with a focus on analytic cross-sectional, case-control studies and cohort studies. Key issues related to statistical approaches, validity of measures of exposure and disease and sources of potential errors in interpreting epidemiologic studies will be addressed. Recommended: PUB_HLTH 421-0. Prerequisites: PUB_HLTH 304-0, PUB_HLTH 302-0.

**PUB_HLTH 425-0 Introduction to GIS and Spatial Analysis for Public Health (1 Unit)**
This course is an introduction to GIS and the collection, maintenance and analysis of spatial data for health. It combines practical ArcGIS skills with study of the theory and applications of spatial data and spatial analysis in general and specifically as it relates to population health.

**PUB_HLTH 430-0 Global Health Research Practicum (1 Unit)**
Students will learn to design an evidence-based and culturally appropriate global health research project or program. Specifically, students will gain competence in analyzing needs and resources; developing a technically and programmatically sound causal pathway; articulating program objectives; designing relevant program components and partnerships, implementing a program, planning program monitoring and evaluation, and ensuring program sustainability.

**PUB_HLTH 431-0 Basic Decision Analysis and Models of Medical Decision Making (1 Unit)**
This course covers quantitative analytic techniques intended to inform decision makers at the bedside, researchers, and those involved with policy-making. Topics include probability, Bayes’ theorem, sensitivity and specificity of diagnostic tests, and decision psychology, with a focus on decision analysis, utility assessment, and cost-effectiveness analysis.

**PUB_HLTH 435-0 Health Services Research Design & Analysis Strategies: Technology Assessment (1 Unit)**
This course is an independent study research seminar based on individual student meetings with the instructor and other faculty mentors. The course focuses on completion of a health services research or health policy paper and oral presentation, often in conjunction with MPH program Culminating Experience requirements. Papers require health services research methodological and study design skills or the conceptual and analytical skills needed for public health history or health policy analyses. Learning objectives include applying health services research methods to a public health, clinical policy or public policy problem or debate, describing factors underlying geographic or provider variations in medical practice or health outcomes, using quality measurement, quality improvement, patient safety or epidemiologic research techniques, conducting risk adjustment for evaluation of medical or behavioral health interventions, and addressing critical issues in social determinants of health or social epidemiology. Enrollment requires prior consent of the instructor.

**PUB_HLTH 437-0 Practicum on Epidemiologic Research Design & Data (1 Unit)**
This course provides hands-on experience in the design and analysis of epidemiologic studies, with emphasis on applying methodology learned in intermediate level courses. Through independent projects and class exercises, the course covers practical aspects of conducting research. Public Health students are encouraged to bring ideas for their culminating experience to the course so that they can further develop and refine their research plan.

**PUB_HLTH 438-0 Survey Design & Methodology (1 Unit)**
This course focuses on methodological issues regarding the design, implementation, analysis and interpretation of surveys and questionnaires in Public Health research. Various types of self-report data will be discussed, including knowledge, attitudes, behaviors and patient-reported outcomes. Issues will include formatting and layout, wording of items and response scales, multilingual translations, sampling, timing of assessments, interviewer training, participant recruitment, data analysis and respondent and staff burden.

**PUB_HLTH 439-0 Qualitative Research Methods (1 Unit)**
This course focuses on qualitative research design, sampling, data management, analysis and report writing. Methods covered include cognitive interviewing for survey construction, individual and group interview methodologies, participant observation, writing and using field notes, cognitive tasks such as decision modeling, domain analysis and the use of mapping techniques in qualitative research. Data analysis instruction includes thematic analyses and code development, consensus and network analyses and an overview of qualitative data management programs.
This course-based course provides students with knowledge of the issues surrounding the ethical conduct of research including making ethical choices in the face of conflicts, and gaining a familiarity with the regulations governing human subjects research.

This is a seminar series focusing on the health aspects of humanitarian crisis response. The course will emphasize the public health aspects (e.g., not the medical or clinical aspects) of response, including rapid assessments, water and sanitation management, shelter, nutrition, communicable disease control, logistics, security and ethical issues. Practical projects, based on simulated disasters, will be assigned and discussed.

This course covers advanced decision-analytic methods useful in medical decision modeling. Included are the probabilistic theory of Hazard rates and modeling of age-dependent mortality, Markov modeling, stochastic tree modeling, techniques for multi-way sensitivity analysis such as probabilistic sensitivity analysis and information-value analysis and software of stochastic tree modeling. Medical decision-analytic literature is reviewed and theoretical underpinnings of models are explored. A project using decision analysis software is required.

Writing and Peer Reviewing is an intensive, hands-on, advanced course in writing for publication in biomedical journals and how to be a successful peer reviewer. The student will be expected to prepare an article, respond to two peer review cycles and at the conclusion of the course, to be ready to submit to a journal.

This course introduces commonly used designs for clinical trials, methods for randomization, blinding and sample size determination, choice of controls, collaborative/multicenter trial requirements and operational issues, data management and data quality issues, interim analysis methods, critical review of clinical trial results and statistical techniques for analyzing data.

This course provides an introduction to the health needs of women and children and the services designed to meet these needs. It introduces the epidemiology of maternal and child health (MCH) and the evidence base for MCH programs. The course provides students with a comprehensive knowledge base with respect to federal funding and other public programs addressing MCH.

This course addresses how public policy development and analysis have an impact on the public's health. The course is designed to provide professionals with the skills for collecting, analyzing and communicating information on public health policy issues using approaches that would be useful in the policymaking arena. Students will learn what policy is; who the policymakers are in public health; who the actors are that are affected by Public Health policy; and the major influences in determining what policy gets implemented, including the science underlying policy proposals.

Advanced Global Public Health will provide an in depth exploration of the current approaches to eradicating long-term social and economic inequalities in health outcomes around the world. We will begin with a review of the current state of global health, highlighting the areas of major gains since 2000, discourse on global health governance, and current trends and emerging health challenges (e.g., chronic metabolic diseases, emerging/re-emerging infectious diseases, humanitarian emergencies). We will then directly examine the diverse strategies that have been used to improve health outcomes in low- and middle-income countries. These strategies range from biomedical interventions (e.g., vaccine campaigns, nutritional supplementation) to broader, macro-level approaches such as targeted cash transfers and agricultural reform. Drawing on detailed case studies, we will explore (a) the nature and structure of global health interventions, (b) the creation of successful partnerships for sustaining health outcomes, and (c) the importance of data collection and analysis for monitoring the effectiveness of program interventions.

This course provides a close examination of how human behavior affects the development and spread of so-called "artificial epidemics," primarily covering non-communicable diseases affecting adults. Diseases and conditions will be examined in order to discern the epidemiology of the disease and how cultural influences can impact both the rise of diseases as public health issues and their subsequent decline in incidence with a view toward prevention of future outbreaks. The course is designed as a "flipped classroom"; students will review materials in advance of the class session and come prepared to share and discuss the week's topic in class. Thus there is an exceptional long reading list each week and only 1 hour of classroom, rather than 90 minutes, per week in this ½ unit class.

This course provides a close examination of how human behavior affects the development and spread of so-called "artificial epidemics," primarily covering non-communicable diseases affecting women and children. Diseases and conditions will be examined in order to discern the epidemiology of the disease and how cultural influences can impact both the rise of diseases as public health issues and their subsequent decline in incidence with a view toward prevention of future outbreaks. The course is designed as a "flipped classroom"; students will review materials in advance of the class session and come prepared to share and discuss the week’s topic in class. Thus there is an exceptional long reading list each week and only 1 hour of classroom, rather than 90 minutes, per week in this ½ unit class.

The course will cover selected topics in cardiovascular disease with critical analysis of the current epidemiologic literature. Students will have the opportunity to study methodological issues, contemporary findings and recommendations for future research.

The purpose of this course is to review the basic concepts and issues relevant to cancer epidemiology. Specifically, this course will focus on interpreting cancer statistics and describing the current state of knowledge regarding the etiology and risk factors for the major cancer sites. In addition, issues in research design and interpretation within the context of cancer epidemiology, as well as the molecular and cellular basis of carcinogenesis as it pertains to cancer occurrence in populations will be discussed. The course is appropriate for students who have an introductory knowledge of epidemiology.
Development and presentation of a culminating research or service project based on one month (or at least 200 contact hours) of fieldwork in a community agency or work on a research project of the student’s choosing (with guidance from a faculty member) in consultation with an adviser or advisory committee. Student presents a seminar and submits a paper on the project.

**Quantitative & Systems Biology (QSB)**

**QSB 401-0 Research Techniques, Writing & Presentation (1 Unit)**
Students will receive training in instruments, techniques and theory of experiments that will be used in their thesis research. Students will also learn how to present scientific work in different formats including written abstracts and outlines, and oral presentations. Presentations by speakers in the MBS seminar series will be critiqued to illustrate principles of effective communication.

**QSB 499-0 QSB Masters Research (1 Unit)**
This course is taken by students in the Quantitative and Systems Biology program. It consists of research in the student's research laboratory.

**QSB 590-0 QSB Thesis Research (3 Units)**
This course is taken by students in the Quantitative and Systems Biology program. It consists of research in the student’s research laboratory and preparing their masters thesis.

**Radio/Television/Film (RTVF)**

**RTVF 301-0 Race & Ethnicity in Film & TV (1 Unit)**
How race and ethnicity are depicted in film and media; audience response, activism, and/or alternative media production by groups of color.

**RTVF 310-0 Television History (1 Unit)**
Political, cultural, social, and industrial history of television, from the classic network era to the post-network contemporary period of media convergence. Exploration of programs as well as major events and shifts in television history.

**RTVF 312-1 History of Film I (1 Unit)**
International survey of motion pictures as a distinctive medium of expression from its prehistory to the present.

**RTVF 312-2 History of Film II (1 Unit)**
International survey of motion pictures as a distinctive medium of expression from its prehistory to the present.

**RTVF 313-1 Doc Film History & Criticism (1 Unit)**
Survey of the schools, styles, and purposes of documentary film as a unique form of artistic expression and sociopolitical persuasion.

**RTVF 313-2 Documentary Film & Video (1 Unit)**
Contemporary work and issues in documentary film and video.

**RTVF 321-0 Radio/Tv/Film Authorship (1 Unit)**
Idea of authorship in the media and an examination of different uses of author theory related to the work of particular artists.

**RTVF 322-0 Radio/Television/Film Genre (1 Unit)**

Concept of genre in the media, with reference to popular American forms.

**RTVF 323-1 Experimental Film: History and Criticism (1 Unit)**
Films and theories of experimentalists since the 1920s; contemporary underground movement.

**RTVF 323-2 Experimental Film & Video (1 Unit)**
Contemporary work in experimental film and video.

**RTVF 325-0 Film, Media & Gender (1 Unit)**
Explores issues of gender in film and media. Introduces students to major debates and theories regarding gender and sexuality in the media.

**RTVF 326-0 Film & TV Criticism (1 Unit)**
Contemporary critical methods applied to film and/or television. Students read literature on critical methods and analysis and write critical analyses of films and television programs.

**RTVF 330-0 Culture Industries (1 Unit)**
Overview of business and social organization of film and television industry. Introduction to how media industries produce cultural products for local, national, and transnational audiences.

**RTVF 331-0 Regulation Of Broadcasting (1 Unit)**
Government regulation and industry self-regulation; historical perspective and examination of current issues.

**RTVF 341-0 Technological Innovations (1 Unit)**
How technology develops and is assimilated into mass media.

**RTVF 345-0 History of Hollywood Cinema (1 Unit)**
Overview of the development of the classical Hollywood cinema, with particular emphasis on the 1920s through the early 1960s. Explores the relationship between industry practices and aesthetic features of classical narrative film genres.

**RTVF 351-0 National Cinema (1 Unit)**
Historical aspects of cinema in a culture outside the United States or a social/cultural/ intellectual movement within cinema's general evolution.

**RTVF 353-0 Film, Media, and Globalization (1 Unit)**
Explores theories of media's role in the globalization of cultures. Examines transnational production, marketing, and reception of film, television, and/or digital media.

**RTVF 358-0 Topics in Improv (1 Unit)**
In-depth study and practice of improv techniques and aesthetics. Sample topics include Intro to Improv, Improvising Characters, Writing and Performing Stand-up, Writing with Improv, Improvising the Text-based Collaborative Show, Improvised Comedy Web Series.

**RTVF 360-0 Topics in Media Writing (1 Unit)**
Various approaches to screenwriting, emphasizing different modes and genres, such as the short film, the feature film, screenplays based on preexisting material, the teen film, interactive computer scenarios. May be repeated for credit, depending on the change in topic. Prerequisite: RTVF 260-0.

**RTVF 370-0 Topics in Pre-Production (1 Unit)**
In-depth study of preproduction film, video, and media techniques and aesthetics. Sample topics include storyboarding, producing, and motion graphics. Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

**RTVF 372-0 Editing (1 Unit)**
The technique and art of editing for film. Topics include editing for continuity, controlling pace and rhythm, and editing nonlinear narratives.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 373-0 Topics in Sound (1 Unit)
In-depth study of sound techniques and aesthetics.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 374-0 Topics in Cinematography (1 Unit)
In-depth study of cinematography techniques and aesthetics.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 375-0 Designing for the Internet (1 Unit)
Design concepts as they relate to the web in an intensive studio/workshop environment.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 376-0 Topics in Interactive Media (1 Unit)
Exploration of the techniques and aesthetics of interactivity using various media.
Prerequisites: RTVF 190-0, second-year standing (not through AP credits), and consent of instructor.

RTVF 377-0 Topics in Non-fiction Media (1 Unit)
In-depth study of postproduction film, video, and media techniques and aesthetics. Sample topics include color correction, special-effects cinematography, and finishing.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 378-0 Topics in Post-Production (1 Unit)
In-depth study of postproduction film, video, and media techniques and aesthetics. Sample topics include color correction, special-effects cinematography, and finishing.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 379-0 Topics in Film/Video/Audio Production (1 Unit)
In-depth study and practice of one area of film, video, or television. May be taken more than once for credit, depending on changes in topic.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 380-0 Lighting and Cinematography (1 Unit)
Techniques, aesthetics, and technologies of lighting and camera skills, including film and video.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 383-0 Introduction to Sound Production (1 Unit)
Introduction to the theories and principles of basic sound production. Demos, lectures, readings, screenings, and exercises cover all basics of sound recording technology.
Prerequisite: RTVF 190-0.

RTVF 384-0 Introduction to Sound Postproduction (1 Unit)
Introduction to the theories and principles of basic sound production. Demos, lectures, readings, screenings, and exercises cover all basics of sound recording technology.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 385-0 Integrated Media Arts (1 Unit)
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 390-0 Directing (1 Unit)
Single-camera dramatic directing, including visualization and breakdown of scripts, camera blocking, and working with actors.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 392-0 Documentary Production (1 Unit)
Students examine documentary practices and produce their own shorts.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 393-0 2D Computer Animation (1 Unit)
Animation techniques in the 2-D sphere and incorporation of visual design principles.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 394-0 Experimental Media Production (1 Unit)
Creation of an experimental work as a linear film or video, an interactive website, an installation, a game, or a multidisciplinary performance.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 395-0 Computer Animation: 3D (1 Unit)
The fundamental concepts and techniques of 3-D computer modeling and animation. Use of concepts acquired in camera-based production techniques to create a rendered animation.
Prerequisites: RTVF 190-0 and second-year standing (not through AP credits).

RTVF 398-0 Symposium: Issues in RTVF (1 Unit)
Special issues and topics in the analysis of radio, television, film, and popular culture.

RTVF 402-0 Television and Media Theory (1 Unit)
Seminar in the key historical and contemporary debates shaping the study of television and emerging electronic media.

RTVF 403-0 Media and Cultural Theory (1 Unit)
Seminar in cultural theory with emphasis on issues of cultural production in film, television, and digital media. Course is not repeatable with multiple topics.

RTVF 410-0 Media Historiography (1 Unit)
Introduction to historiography with emphasis on the research and writing of history in film, television, and digital media.

RTVF 411-0 Cultural History of Television (1 Unit)
This course is a critical investigation of the history of U.S. television focusing on the classic 3-network era. This course will provide a background into the events surrounding the emergence of TV as a technology, industry and cultural form.

RTVF 412-0 Cultural History of Film (1 Unit)
This course offers an introductory survey of world film history from the 1890s to the outbreak of World War II. We will examine a wide range of films, feature-length narratives as well as animated, experimental, and early shorts, and place them in their historical and cultural context.

RTVF 413-0 Cultural History of New Media (1 Unit)
This class introduces students to key debates surrounding the history of new media and digital media cultures. Taking a media studies approach, we will investigate issues of technological innovation from the 19th century to the new digital media of the present.

RTVF 420-0 Film Theory & Criticism (1 Unit)

RTVF 422-0 Textual Analysis (1 Unit)
Seminar in the textual analysis of film, television, and digital media.

RTVF 426-0 Global Media (1 Unit)
Seminar in historical and contemporary issues related to media and globalization.

RTVF 443-0 Advanced Seminar in Film & Video (1 Unit)
RTVF 464-0 Advanced Media Writing (1 Unit)
An advanced writing course primarily emphasizing dramatic writing for feature film and television. At the discretion of the instructor, the course emphasizes one of several types of writing such as episodic television, television movies, playwriting, genre films, comedies, action/adventures, and adaptation. Offered yearly. Prerequisites: RTVF 260-0 and admission by permission of instructor.

RTVF 472-0 Advanced Editing (1 Unit)
The technique and art of editing for film. Topics include editing for continuity, controlling pace and rhythm, and editing nonlinear narratives. Prerequisites: RTVF 380-0 and second-year standing (not through AP credits).

RTVF 475-0 Grad Prod Wkshop (1 Unit)
Intensive introduction to media production and aesthetics that includes still photography, computer simulations of production problems, and extensive small-format video production and editing. Prerequisites: Permission of instructor.

RTVF 476-0 Advanced Cinematography (1 Unit)
Continuation of work started in RTVF 380 Lighting and Cinematography; greater emphasis on developing advanced lighting skills. Work on industry standard 16mm film cameras and High Definition video cameras. Detailed scene studies focusing on color, composition, and camera movement. Prerequisites: RTVF 380-0, or permission of instructor.

RTVF 478-0 Film & Video Post Production (1 Unit)
An advanced study of film editing and finishing practices and procedures, videotape off-line and on-line editing, and ways in which film and videotape interface in postproduction. Prerequisites: RTVF 380-0.

RTVF 479-0 Seminar: Studies in Film and Video Prod (1 Unit)
An advanced study and practice of one aspect of film and video making, such as scriptwriting, lighting, cinematography, directing, sound recording, or editing. May be repeated for credit no more than twice. Prerequisites: RTVF 380-0.

RTVF 490-1 Summer Internship Seminar (0 Unit)
This course occurs concurrently during a student’s summer internship to provide a structured approach to the internship experience. Through weekly readings and assignments students will assess their own skills, experiences, and interests to develop a personal plan on how to best approach their internships and further their career goals. A special emphasis will be placed on developing professional practices that will prepare students for finding work in the entertainment industry after graduation. Prerequisites: 1. Completion of year 1 of their MFA. 2. Accepted for an internship in the summer quarter of their first year that has been approved by EPICS and program faculty. Students will be automatically enrolled in the Fall Internship Capstone (RTVF 490-2) for fall quarter, which is a companion class to this course.

RTVF 490-2 Fall Internship Capstone (1 Unit)
This course is a continuation of the Summer Internship Seminar (RTVF 490-1), where students will pull from their experience both at their internship and in the seminar to complete their capstone projects. These projects will focus on different methods and strategies for applying to professionally relevant opportunities in their respective fields.

RTVF 491-0 Fall Internship Seminar (1 Unit)
This course occurs concurrently during a student’s fall internship in order to provide a structured approach to their internship experience. Through weekly readings and assignments students will assess their own skills, experiences, and interests to develop a personal plan on how to best approach their internships in order to further their career goals. A special emphasis will be placed on developing professional practices that will prepare students for finding work in the entertainment industry after graduation. At the end of the course, students will complete a capstone project that will focus on different methods and strategies for applying to professionally relevant opportunities in their respective fields.

RTVF 499-0 Independent Study (1 Unit)
Permission of instructor and department required. May be repeated for credit.

RTVF 502-0 Writing Practicum (1 Unit)
RTVF 551-0 Documentary Techniques (1 Unit)
Intro to basic camera and sound recording for traditional small-crew documentary filmmaking; interviewing; ethics; successful story structure that engages and innovates. Product: 6-8 minute documentary film.

RTVF 552-0 Narrative Techniques (1 Unit)
Intro to small-crew narrative sync-sound filmmaking; hybridization, narratives that use doc techniques, docs that use narrative techniques; additional documentary equipment. Product: 6-8 minute narrative film.

RTVF 553-0 Interactive Techniques/ Emerging Forms (1 Unit)
Intro to basic interactivity platforms and how to apply documentary methodology. Product: One interactive project.

RTVF 554-0 Thesis 1 (1 Unit)
Development and major period of field production of documentary media thesis project. Product: concept, treatment, assembly/selects or completed plan for interactive prototype.

RTVF 555-0 Thesis 2 (1 Unit)
Post-production of thesis with emphasis on transitioning from fieldwork to assemblage. Product: Rough-cut or working interactive prototype.

RTVF 556-0 Thesis 3 (1 Unit)
Finish thesis project; organize final public screening and exhibitions; intro to the business of documentary media production/distribution. Product: Thesis project, artist statement, PR/marketing materials, career plan.

RTVF 561-0 Foundations of Writing for Screen & Stage (1 Unit)
RTVF 562-0 Writing the Short Play (1 Unit)
RTVF 563-0 Writing the TV Episode (1 Unit)
RTVF 564-0 Full Length Project (1 Unit)
RTVF 565-0 Full-length Project II (1 Unit)
RTVF 566-0 Full-length Project III (1 Unit)
RTVF 584-0 Research Seminar (1 Unit)
Topics vary.

RTVF 590-0 Research (3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.

Religion (RELIGION)
RELIGION 312-0 Buddhism and Gender (1 Unit)
Women, men, and gendered symbolism in Buddhism from the time of the Buddha to the present. Draws on canonical texts, narrative literature, autobiography and biography, and ethnography.

Ethics Values Distro Area
RELIGION 313-0 Tibetan Religion and Culture (1 Unit)
Propagation of religions in Tibet in their larger historical, cultural, and political contexts.
Ethics Values Distro Area

RELIGION 339-0 Topics in Judaism (1 Unit)
Content varies. May be repeated for credit with change of topic.
Ethics Values Distro Area

RELIGION 375-0 Foundations of Christian Thought (1 Unit)
Christian interpretations of salvation, Christ, and God, from Augustine to Julian of Norwich.
Ethics Values Distro Area

RELIGION 376-0 Christianity and the Making of Modernity (1 Unit)
Role of Christian thought in shaping the turbulent history of the West from the 16th to the late-18th centuries. Christianity's engagement with local and global events, from reformation to revolution, reason to romanticism.
Ethics Values Distro Area

RELIGION 377-0 Christian Thought in Global Perspective (1 Unit)
Globalization of Christian thought in the 19th-21st centuries, considering religious differences, colonialism, war, and democracy. Approaches to theology in Asia, Latin America, and Africa.
Ethics Values Distro Area

RELIGION 440-0 Topics Buddhism (1 Unit)
May be repeated for credit with change of topic.

RELIGION 460-0 Seminar: Topics in Christianity (1 Unit)
May be repeated for credit with change of topic.

RELIGION 462-0 Topics in American Religious History & Contemporary Practice (1 Unit)
The intersection of race, religion, and class-as a generative convergence, as well as tragedy and outrage-is at once everywhere and nowhere in US religious history. This course considers the strange fate of this convergence through a careful consideration of recent work that aims to recover particular pieces its history.

RELIGION 470-0 Theology and the Study of Religion (1 Unit)
An historical exploration of the study of religion, from the nineteenth century to the present, in relation to theological themes. Also addressed are constructive issues concerning the contemporary relation between theology and religious studies.

RELIGION 471-0 Studies in History of Religions (1 Unit)
May be repeated for credit with change of topic.

RELIGION 472-0 Studies in Literature of Religion (1 Unit)
May be repeated for credit with change of topic.

RELIGION 473-0 Studies in Buddhism (1 Unit)
May be repeated for credit with change of topic.

RELIGION 474-0 Studies in Judaism (1 Unit)
May be repeated for credit with change of topic.

RELIGION 475-0 Studies in Christianity (1 Unit)
May be repeated for credit with change of topic.

RELIGION 476-0 Studies in Islam (1 Unit)
May be repeated for credit with change of topic.

RELIGION 481-0 Classical Theories of Religion (1 Unit)
This course explores the writings of well-known European and American philosophers, anthropologists, sociologists, psychologists, and historians who wrote between the late eighteenth and mid-twentieth centuries and who have shaped the foundations of scholarly and public perceptions of religion over approximately the past 150 years.

RELIGION 481-1 Classical Theories of Religion (1 Unit)

RELIGION 481-2 Contemporary Theories of Religion (1 Unit)
In this seminar, we trace the emergence of the category of religion as an object of scholarly inquiry and cross-cultural comparison, with particular attention to how the category emerged in the context of European colonialism and imperialism in the 19th and 20th centuries.

RELIGION 482-0 Themes in Comparative Religion (1 Unit)
Theoretical and methodological approaches to comparative work in religious studies. Content varies.

RELIGION 490-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS Independent investigation of selected problems pertaining to thesis or dissertation.

RELIGION 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS Independent investigation of selected problems pertaining to thesis or dissertation.

RELIGION 570-1 Research Seminar (1 Unit)
Research seminar for advanced graduate students. Two quarters of registration required for completion of two-quarter research projects.

RELIGION 570-2 Research Seminar (1 Unit)
Research seminar for advanced graduate students. Two quarters of registration required for completion of two-quarter research projects.

RELIGION 570-3 Research Seminar (1 Unit)
Research seminar for advanced graduate students. Two quarters of registration required for completion of two-quarter research projects.

RELIGION 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS Independent investigation of selected problems pertaining to thesis or dissertation.

Reproductive Science and Medicine (REPR_SCI)

REPR_SCI 405-0 Female Reproductive Physiology and Endocrinology (1 Unit)
A lecture-based course that provides a comprehensive survey of the structure and function of the female reproductive system. Throughout the quarter, students will discuss the fundamentals of female reproductive anatomy and reproductive axis function (hypothalamus-pituitary-gonadal). Specific topics that will be covered include: female sex determination and differentiation, reproductive hormone signaling and action, the ovarian and menstrual cycles, oogenesis and folliculogenesis, pregnancy and parturition, and female reproductive technologies.

REPR_SCI 406-0 Emerging Research in Reproductive Science and Medicine (1 Unit)
This is a primary literature and critical thinking-based course designed to challenge students with historical, contemporary, and emerging concepts in reproductive science and medicine.

REPR_SCI 407-0 Male Reproductive Physiology and Endocrinology (1 Unit)
A lecture-based course that provides a comprehensive survey of the structure and function of the male reproductive system. Throughout the quarter, students will discuss the fundamentals of male reproductive anatomy and reproductive axis function (hypothalamus-pituitary-gonadal).

REPR_SCI 415-0 Medical Management of Fertility: From Contraception to ART (1 Unit)
This is a lecture and laboratory course that exposes students to assisted reproductive technologies (ART), embryology, and andrology. Course topics include gamete and embryo biology, assisted reproductive techniques and associated technologies, ethics, and an introduction to fertility clinic operation.
Prerequisites: REPR_SCI 405-0 and REPR_SCI 407-0.

REPR_SCI 420-0 Human Reproductive Health and Disease (1 Unit)
Major disorders of the male and female reproductive system are covered. The molecular basis, pathophysiology, and current status of research and treatment are considered. Topics include sexual function and dysfunction, infertility, reproductive aging, reproductive cancers, endometriosis, uterine leiomyoma, and pregnancy complications. Prerequisites: REPR_SCI 405-0 and REPR_SCI 407-0.

REPR_SCI 425-0 Responsible Conduct of Research in Reproductive Science (1 Unit)
This course provides instruction and guidance on the responsible conduct of research. NIH defines the responsible conduct of research as the practice of scientific investigation with integrity. The responsible conduct of research involves the awareness and application of established professional norms and ethical principles in the performance of all activities related to research. Students will receive instruction and discuss a variety of topics required to perform high quality research with integrity, transparency, rigor, and reproducibility from experts in these areas and faculty conducting reproductive science research.

REPR_SCI 440-0 Reproductive Technologies Laboratory (1 Unit)
This is an intensive laboratory-based course designed to provide students with exposure to a range of topics and associated technologies used in reproductive science and medicine.

REPR_SCI 442-0 Reproductive Research I (1 Unit)
This laboratory course is specifically designed to lead students through a hypothesis driven, discovery based research project stemming from current research questions in reproductive science including but not limited to: factors important to reproductive organ development, signaling pathways that inform reproductive organ structure and function, and molecular and cellular pathways implicated in reproductive disease. Prerequisites: REPR_SCI 405-0, REPR_SCI 407-0, REPR_SCI 425-0.

REPR_SCI 443-0 Reproductive Research II (1 Unit)
This course is a continuation of REPR_SCI 442-0. REPR_SCI 443-0 will shift to advancing data acquisition and analysis, expanding project design directions and enhancing oral and written scientific communication. Prerequisites: REPR_SCI 405-0, REPR_SCI 407-0, REPR_SCI 425-0, and REPR_SCI 442-0.

REPR_SCI 450-0 Presentations in Reproductive Science and Medicine (1 Unit)
A seminar attendance and discussion course designed to support retention and application of the information presented in a range of seminars, grand rounds, and data clubs.

REPR_SCI 455-0 Research Proposals (1 Unit)
A writing intensive course designed to teach students how to write and evaluate scientific research proposals. Students will practice writing, editing, and giving constructive criticism through assignments and group activities. The class culminates in a mock study section.

REPR_SCI 497-0 Assessment and Career Planning (1 Unit)
This course is designed to provide students with skills and resources to evaluate themselves in light of their career and professional goals. Students receive instruction on self-assessment and professional development planning. This course does not specifically prepare students for any one career. Rather, recognizing that professional development is a continuous process, this course provides students the skills and resources to uncover their unique strengths relevant to the professional world of reproductive science and medicine.

REPR_SCI 591-0 Thesis Research in Reproductive Science and Medicine (1-3 Units)
During this course, students will prepare a written thesis describing their research project including the research question/hypothesis, rationale and significance, a literature review, experimental approach, data and results, and future directions. Prerequisite: REPR_SCI 595-0.

REPR_SCI 595-0 Research in Reproductive Science and Medicine (1-3 Units)
Students will become integrated members of their laboratory or research group and commit a minimum of 20 hours per week to research. Research mentors will evaluate student research commitment and progress and assign the grade for the course.

Segal Design Institute (DSGN)

DSGN 350-0 Intellectual Property and Innovation (1 Unit)
The critical role of engineers in the invention/creative process and of technologists in wealth creation. Prerequisite: senior standing or consent of instructor.

DSGN 375-0 Data as Art (1 Unit)
Information visualization across multiple disciplines.

DSGN 395-0 Special Topics (1 Unit)
Topics relevant to design engineering and approved by the institute. Prerequisite: consent of instructor.

DSGN 401-1 Human-Centered Design Studio 1 (1 Unit)
This course is part one of a year-long studio course, providing a project-based introduction to the engineering design of products and processes that meet human needs. Students are given a problem area in which to innovate and will be led through the process of investigating cultural, emotional, technological and business factors, developing new concepts, creating and testing prototypes, and iterative design. Principal focus will be placed on understanding the interaction of people and products/services. Formal interaction modeling techniques will be introduced, and students will learn to prototype interactive systems. Teaching methods include lectures, labs, reading, homework assignments and projects.

DSGN 401-2 Human-Centered Design Studio 2 (1 Unit)
This course builds upon DSGN 401-1, continuing the theme of interaction design. In the first part of the course, students are given a problem area, but will be challenged to explore novel and multimodal approaches to interaction, including gestural, tactile, auditory, and others. Methods of prototyping interactive mechatronic systems will be introduced. In the second part of the course students are challenged to design an experience which grows out of the interactions between a person and a product or service. Personas, use cases and scenarios will be introduced for modeling experiences. Teaching methods include lectures, labs, reading, homework assignments and projects.

DSGN 401-3 Human-Centered Design Studio 3 (1 Unit)
This course is part three of a year-long studio course, providing a project-based introduction to the engineering design of products and processes that meet human needs. Students are given a problem area in which to innovate and will be led through the process of investigating cultural, emotional, technological and business factors, developing new concepts, creating and testing prototypes, and iterative design. Principal focus will be placed on understanding the interaction of people and products/services. Formal interaction modeling techniques will be introduced, and students will learn to prototype interactive systems. Teaching methods include lectures, labs, reading, homework assignments and projects.

DSGN 410-0 Design Research (1 Unit)
In this course, students learn the value of field research in the human-centered design process.

DSGN 420-0 Design Communication & Methods (1 Unit)
This course teaches how to translate complex information, extracted from the strategic design process into simple visual solutions. This class will help students create visualization of their ideas through using digital aids such as: Photoshop, Illustrator, Indesign, Powerpoint, Mind map, Solidworks, Keyshot, etc. Students who take this class can apply these methods to their future projects, helping them express their ideas to others, by making their ideas more visible, tangible, and real, creating a better emotional connection with their audience. But most importantly, this class will allow students to develop new creative methods in design
processes and give back to the design community. Open to non-majors, with priority given to EDI students.

DSGN 450-0 Differentiation by Design (1 Unit)
Introduces students to opportunities for innovation throughout the entire new product development process. Lectures supported by case studies, readings, relevant outside experts, and real world examples.

DSGN 455-0 Design Strategy (1 Unit)
The intention of this course is to introduce the student to the power of design as a differentiator in the marketplace. The one thing we know is that change is constant. Consumer culture and values evolve, business conditions change, and new technologies develop. More often than not the influence of human centered design and strategic design thinking is leading the charge in meaningful innovation that both consumers and business find relevant. Successful organizations innovate, through deep understandings of their customer, in order to stay relevant to their constituencies and competitive in the market. And while innovation is dependant on design, strategic design requires management. This course will be highly interactive with real world examples and case studies, guest lectures from industry, class discussions and storytelling, along with hands on design thinking exercises and assignments.

DSGN 495-0 Special Topics in Engineering Design (1 Unit)

DSGN 497-0 Advanced Topics in Engineering Design (0.5 Unit)

DSGN 499-0 Independent Research Project (0.5-2 Units)

DSGN 519-0 Responsible Conduct of Research Training (0 Unit)

**Slavic Languages & Literature (SLAVIC)**

**SLAVIC 310-0 Tolstoy (1 Unit)**
This course is devoted to a careful consideration of one book, Tolstoy’s War and Peace, as we come to appreciate why it is often considered the world’s greatest novel.

*Literature Fine Arts Distro Area*

**SLAVIC 311-0 Dostoevsky (1 Unit)**
Introduction to Dostoevsky’s life and works: Notes from the Underground, Crime and Punishment, Brothers Karamazov.

*Literature Fine Arts Distro Area*

**SLAVIC 314-0 Chekhov (1 Unit)**
Introduction to the fiction and plays of Anton Chekhov, father of the modern short story. His writing in its Russian cultural context and his influence on English-language drama, fiction, and film. Readings include The Cherry Orchard, The Seagull, Uncle Vania, and short stories.

*Literature Fine Arts Distro Area*

**SLAVIC 341-0 Structure of Modern Russian (1 Unit)**
Theories and methods of linguistics as applied to the description of modern Russian. Phonetics, morphology, and other topics.

*Formal Studies Distro Area*

**SLAVIC 360-0 Survey of 19th Century Russian Poetry (1 Unit)**
Introduction to the wealth of Russian 19th century lyric poetry and basic techniques for its study: Pushkin, Baratynsky, Lermontov, Tyutchev, Fet.

*Literature Fine Arts Distro Area*

**SLAVIC 361-0 Survey of 20th Century Russian Poetry (1 Unit)**
Introduction to the major currents of Russian 20th century lyric poetry and basic techniques for its study: Tsvetaeva, Mayakovsky, Khlebnikov, Blok, Akhmatova, Mandelshtam, Pasternak, Brodsky.

*Literature Fine Arts Distro Area*

**SLAVIC 369-0 200 Years of Russian Drama (1 Unit)**

Dramatic traditions of Russia from the 19th century through Russian modernism to contemporary theater. Dramas by Gogol, Ostrovsky, Gorky, Chekhov, Blok, Mayakovsky, and others.

*Literature Fine Arts Distro Area*

**SLAVIC 390-0 Literature and Politics in Central and Eastern Europe (1 Unit)**
Literature has played a central role in defining the political agendas in central and eastern Europe. Course concerns the interaction of literature with cultural and political history. Content varies. May be repeated for credit.

*Historical Studies Distro Area Interdisciplinary Distro - See Rules (https://catalogs.northwestern.edu/undergraduate/arts-sciences/#schoolrequirementstext)*

**SLAVIC 405-0 Russian Teaching Methodology (1 Unit)**
Russian teaching methodology. Addresses the complexities of teaching Russian language.

**SLAVIC 411-0 Proseminar (1 Unit)**
Introduction to the study of Slavic languages and literatures at the graduate level. May be repeated for credit.

**SLAVIC 430-0 Studies in Old Russian Literature (1 Unit)**
Introduction to Medieval Russian Literature and culture.

**SLAVIC 434-0 Studies in 18th Century Russian Lit (1 Unit)**
Introduction to 18th Century Russian Literature and culture. Content varies.

**SLAVIC 435-0 Studies in 19th Century Russian Lit. (1 Unit)**
Introduction to the major currents of 19th Century prose, poetry and culture. Content varies. May be repeated for credit with change of topic.

**SLAVIC 437-1 Poetry Seminar (1 Unit)**
Studies in Poetry and Poetics from 18th - 20th Century. Content varies; mainly covers Russian and Eastern European authors in comparative context. May be repeated for credit with change of topics.

**SLAVIC 438-0 Studies in 20th-Century Russian Literature (1900-1930s) (1 Unit)**
Russian modernism and avant-garde in literature and culture. Content varies. May be repeated for credit with change of topic.

**SLAVIC 438-1 20th-Century Russian Prose (1940s-present) (1 Unit)**
Soviet and post-Soviet contemporary Russian prose. Content varies. May be repeated for credit with change of topic.

**SLAVIC 440-0 Studies in Russian Intellectual History (1 Unit)**
Introduction to Russian intellectual history of 19th-20th century in comparative context. Content varies. May be repeated for credit with change of topic.

**SLAVIC 441-0 Studies in Russian Literary and Cultural Criticism (1 Unit)**
Major trends and texts of literary criticism. Aesthetics and politics. Content varies. May be repeated for credit with change of topic.

**SLAVIC 442-0 Bakhtin’s Prosaiscs (1 Unit)**
Bakhtin’s theories of the novel. Topics include: Bakhtin’s theories of genres, language, psychology, time, ethics, interpretation, and implications for current American theory.

**SLAVIC 490-0 Independent Reading (1 Unit)**
Content varies. May be repeated for credit with change of topic.

**SLAVIC 499-0 Independent Study (1 Unit)**
SEE DEPT FOR SECTION AND PERMISSION NUMBERS Permission of instructor and department required. May be repeated for credit.

**SLAVIC 590-0 Research (1-3 Units)**
Sociology (SOCIOL)

SOCIOL 400-0 Introduction to Statistics & Statistical Software (1 Unit)
This course is designed to teach students the basics of single variable calculus, probability, set theory, random variables, and hypothesis testing. The course prepares students for the next class in the statistics sequence. The fundamental math used in this course will be covered in a review course prior to the start of the quarter. By the end of the course, students will understand the intuition behind statistical analysis, have practice applying the statistical techniques covered, and be familiar with different types of statistical analysis.

SOCIOL 401-1 Statistical Analysis of Social Data: Applied Regression Methods I (1 Unit)
Introduction to the theory, methods, and practice of linear regression analysis: descriptive statistics, analysis of variance, ordinary least squares (OLS), non-linear models with linear regression, and regression diagnostics. For first-year graduate students in sociology.

SOCIOL 401-2 Statistical Analysis of Social Data: Applied Regression Methods II (1 Unit)
Regression models with categorical and discrete outcomes: categorical variables, ordinal outcomes, maximum likelihood estimation (MLE), probit and logistic regression, logit models. Other advanced methods may also be covered. For first-year graduate students in sociology.

SOCIOL 402-0 Event-History Analysis (1 Unit)
Statistical techniques for the analysis of longitudinal data to explain or predict the occurrence of discrete events.

SOCIOL 403-0 Field Methods (1 Unit)
Application of the methods of case study, interviewing, and participant observation.

SOCIOL 405-0 Research Methods (1 Unit)
Fundamentals of research methods, sampling, data collection, and data analysis. May include questionnaire design, aspects of archival research, content analysis, and the relationship between methods, analytic techniques, and the building and confirming of theoretical models.

SOCIOL 406-1 Classical Theory in Sociological Analysis (1 Unit)
Marx and Weber: comparison and contrasts of their theories. Also, theorists such as Lukacs and Gramsci, who combine elements from both.

SOCIOL 406-2 Race, Gender, Du Bois & Sociological Theory (1 Unit)
This course addresses the role that social factors play in the development of sociological perspectives and schools of thought. Attention will focus on the role of race, gender and power in the rise of American sociology. The case of W. E. B. Du Bois will be highlighted to shed light on the origins and development of American sociology.

SOCIOL 406-3 Contemporary Theory in Sociological Analysis (1 Unit)
Contemporary approaches to important theoretical issues. Emphasizes the relationship between theory and current research. Content varies. Topics may include functionalism, neo-Marxism, rational action, feminism, or symbolic interactionism. May be repeated for credit with change of topic.

SOCIOL 408-0 Sociology of Law (1 Unit)
Classical and modern theories of law. Modes of inquiry in sociological research. Patterns of legal development; comparisons among capitalist, socialist, customary, and indigenous legal systems. The relationship of law to social control, inequality, and social change. Social organization of legal institutions, including systems of dispute resolution and litigation, the legal profession, and regulatory and enforcement agencies.

SOCIOL 420-0 Cultural Sociology and the Sociology of Culture (1 Unit)
Production, distribution, reception of culture; culture and meaning; cultural approaches to social boundaries, social problems; local and global cultures.

SOCIOL 437-0 Economic Sociology (1 Unit)
This course provides an introduction to economic sociology. It poses the key idea of "embeddedness" and develops it by exploring various connections between economic behavior and social processes and relations.

SOCIOL 439-0 Comparative and Historical Sociology (1 Unit)
Theoretical and methodological issues in the comparison of whole societies and other macrosocial units. Contrasts approaches that emphasize variables with those that emphasize cases (i.e., countries) and their histories. Content varies. May be repeated for credit with change of topic.

SOCIOL 440-0 Stratification, Race and Gender (1 Unit)
Issues in current research and theory in stratification, race, and gender. Content varies. May be repeated for credit with change of topic. For graduate students.

SOCIOL 441-0 Social Movements (1 Unit)
Issues in research and theory in organizations, institutions, and social movements. Content varies. May be repeated for credit with change of topic. For graduate students.

SOCIOL 476-0 Topics in Sociological Analysis (1 Unit)
Advanced areas of graduate student interest. Content varies. May be repeated for credit with change of topic.

SOCIOL 480-0 Introduction to the Discipline (0 Unit)
Introduction to the department, faculty, and adjunct faculty. Faculty discuss their research and teaching interests. Mandatory two-quarter weekly seminar for first-year students.

SOCIOL 490-0 Research: Second Year Paper (1 Unit)
Independent study for work on second-year paper.

SOCIOL 499-0 Independent Study (1 Unit)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

SOCIOL 570-0 Seminar on College Teaching (1 Unit)
This course should be seen as a first step in a never-ending mission for developing one's own pedagogical skills. Students will learn each stage of the collegiate course design and implementation process: creating syllabi, teaching effectively, and evaluating both student and teacher. Assignments throughout the course are designed primarily to help students improve and reflect on their teaching. The final assignment is to create a teaching portfolio that will lay the foundations for what students would use on the academic job market. As part of the course, students gain hands-on teaching experience by the department's 110 course: Introduction to Sociology. Taught for 110 will require students to lead a discussion section every week along with grading essays, midterms, and the final exam. The first two weeks of the course will prepare students to quickly learn and execute their responsibilities.

SOCIOL 576-0 Topics in Sociological Analysis (0.33-0.34 Units)
Workshops in areas of expressed student interest. Open to advanced graduate students. May be counted for credit with instructor approval.

SOCIOL 590-0 Research (1-3 Units)
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.
Spanish (SPANISH)

SPANISH 310-0 Origins of Spanish Civilization (1 Unit)
Introduction to Spanish civilization from its origins to 1453. Focus on the Roman, Visigoth, and Muslim conquests and their differences, the Christian reconquest, and the evolution of Spanish from Latin.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 320-0 Golden Age Poetry and Prose (1 Unit)
Major authors of the 17th century, including Garcilaso de la Vega, Fray Luis de León, and Santa Teresa de Jesús. Works by Cervantes other than Don Quijote.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 321-0 Golden Age Drama (1 Unit)
Major dramatists of the 17th century, including Lope de Vega, Tirso de Molina, Cervantes, and Calderón de la Barca. Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 323-0 Cervantes' Don Quixote (1 Unit)
Close reading of Don Quijote, with attention to its historical and cultural context.
Prerequisite: SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 330-0 Colonial Latin American Literature (1 Unit)
Major texts and writers of the colonial period, including chronicles of discovery and conquest from both indigenous and Hispanic sources. Works by authors such as Inca Garcilaso de la Vega, Bartolomé de las Casas, and Sor Juana Inés de la Cruz.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 331-0 Latin American Modernismo (1 Unit)
Significant poetry, narrative, and criticism from the late 19th and early 20th centuries. Topics such as decadence, aestheticism, the flâneur and the rastacuero, cosmopolitanism, the modern city, and exoticism.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 332-0 Avant-Garde Writers and Experimental Fiction in Spain (1 Unit)
Poetry, prose, and visual art by major figures and groups in 20th century vanguard movements. Works by authors such as Roberto Arlt, Alejo Carpentier, Nicolás Guillén, Vicente Huidobro, and César Vallejo.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 333-0 The Spanish Civil War: The Good Fight (1 Unit)
Analysis of the Spanish Civil War (1936-39) and its effects on 20th century Spanish culture and society. Issues may include the relationship between utopic thought and artistic avant-gardes during this period; literary and filmic representations of the war; and the war's connections to World War II.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 335-0 Modern Fiction in Spain: Studies in Genre (1 Unit)
Study of literary genres (narrative, poetry, drama) or subgenres (detective fiction, autobiography, the fantastic). May be repeated for credit with different topic.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 343-0 Latin American Avant-Gardes (1 Unit)
Theories and practices of realist authors in modern Spanish literature. Issues of literary representation and mimesis. Aesthetic and ideological foundations of realism in the 19th century, and in 20th century variants such as social realism, antirealism, and postmodern documentarism.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 344-0 Borges (1 Unit)
The poetry, essays, and short fiction of Jorge Luis Borges. Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 345-0 Reading the "Boom" (1 Unit)
Historical, literary, and cultural characteristics of the "Boom" in the 1960s and 1970s and the development of the "new" narrative in Latin America. Works by authors such as José Donoso, Carlos Fuentes, Gabriel García Márquez, and Mario Vargas Llosa.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 346-0 Testimonial Narrative in Latin America (1 Unit)
Study of the tradition of testimonial writing in Latin America with attention to cultural, political, and historical contexts and questions of truth, memory, and subjectivity. Works by authors such as Miguel Barnet, Rigoberta Menchú, Elena Poniatowska, Jacobo Timerman, and Rodolfo Walsh.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 347-0 Visual Culture in Latina/o America and Spain (1 Unit)
History and materials of Latin American, Spanish, or US Latina/o visual cultures. Possible topics: photography, exhibitions, video practice, and visual production in popular culture.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.

Literature Fine Arts Distro Area

SPANISH 360-0 Spain: Studies in Culture and Society (1 Unit)
Significant issues in the social, political, and cultural development of Spain. May be repeated for credit with different topic.
Prerequisite: SPANISH 220-0.
Literature Fine Arts Distro Area

SPANISH 361-0 Latin America: Studies in Culture and Society (1 Unit)
Analysis of the history of culture in Latin America with an emphasis on the intersection of politics, society, and literature and on the relationship between literary and visual culture. May be repeated for credit with different topic.
Prerequisite: SPANISH 220-0.
Literature Fine Arts Distro Area

SPANISH 363-0 Topics in US Latina/o Literary and Cultural Studies (1 Unit)
Analysis of diverse literary and/or cultural productions by and about US Latina/o(s). Topics may include the politics of representation, cultural and social identity, race, ethnicity and gender, transnationalism and globalization. Case studies vary across cultural practices, media, and literary texts.
Prerequisite: SPANISH 220-0.
Interdisciplinary Distro - See Rules (https://catalogs.northwestern.edu/undergraduate/arts-sciences/#schoolrequirementstext) Literature Fine Arts Distro Area Social Behavioral Sciences Distro Area

SPANISH 380-0 Topics in Film: The Silver Screen in Latin America and/or Spain (1 Unit)
Introduction to film in Latin America and/or Spain during the 20th century. Topics vary and may include a historical survey of film, a study of films of a specific period, a comparative analysis of literary works and cinematic adaptations, or the work of specific filmmakers. May be repeated for credit with different topic.
Prerequisite: SPANISH 220-0.
Literature Fine Arts Distro Area

SPANISH 395-0 Topics in Latin American, Latina and Latino, and/or Iberian Cultures (1 Unit)
Advanced study of topics in the literary traditions of either Latin America or Spain. Possible topics include intellectual history, transatlantic exchanges, literature of the fantastic, feminist traditions, hybrid cultures, and history and fiction. May be repeated for credit with different topic.
Prerequisite: 1 course from SPANISH 250-0, SPANISH 251-0, SPANISH 260-0, or SPANISH 261-0.
Literature Fine Arts Distro Area

SPANISH 397-0 Topics in Latin American, Latina and Latino, and Iberian Literatures and Cultures (1 Unit)
Aspects of the literatures and cultures of Latin America and Spain. Possible topics include postcolonial criticism and its reception in Hispanic cultures, notions of translation, theories of poetics, orality and oral culture, the memoir, and travel writing. May be repeated for credit with different topic.
Literature Fine Arts Distro Area

Spanish and Portuguese (SPANPORT)

SPANPORT 410-0 Topics in Early Modern Literatures and Cultures (1 Unit)
Analysis of primary works and the major critical theories and debates regarding the literary and cultural production of the Early Modern period (Golden Age Spain and/or Colonial Latin America).

SPANPORT 415-0 Studies in 19th Century Literatures & Cultures (1 Unit)
Analysis of the discursive models of nineteenth and early twentieth-century Latin American and/or Iberian literary and cultural production. Topics vary. May be repeated for credit with a different topic.

SPANPORT 420-0 Studies in 20th Century Literatures & Cultures (1 Unit)
Analysis of movements, trends, and issues in twentieth-century Latin American, Iberian, and/or U.S. Latino literary and cultural production. Topics vary. May be repeated for credit with different topic.

SPANPORT 425-0 Studies in Contemporary Literatures & Cultures (1 Unit)
Analysis of recent movements, trends, and issues in recent Latin American, Iberian, and/or U.S. Latino literary and cultural production. Topics vary. May be repeated for credit with different topic.

SPANPORT 430-0 Topics in Latino/a Literatures & Cultures (1 Unit)
Analysis of the major critical theories, debates and proposals regarding the literary and cultural production of U.S. Latino/as, including popular culture, the media, and expressive arts.

SPANPORT 450-0 Topics in Cultural Studies (1 Unit)
Analysis of specific topics and debates within cultural studies and visual culture in Latin American and/or Iberia. Thematic focus varies. May be repeated for credit with different topic.

SPANPORT 455-0 Comparative Studies in Latin American and/or Iberian Literature & Cultures (1 Unit)
Study of diverse works, figures, genres, and traditions from Latin America and/or Iberia that have engaged with related topics, forms, and/or currents from inside and outside these regions. Focus and materials will vary each year.

SPANPORT 480-0 Topics in Latin American Literature and/or Iberian Literatures & Culture (1 Unit)
This seminar course explores Iberian and Latin American cultural and political issues in relation to particular representational techniques, prominent literary traditions, subject-and national-making practices, and varied forms of writing literary texts. Topics vary.

SPANPORT 490-0 Current Readings in Latina/o American and Iberian Criticism and Theory (1 Unit)
This course will involve intensive student-driven reading and discussion on current topics in Latin American and Iberian theory and criticism. It will be run as a tutorial and an environment for intellectual exchange. It is encouraged as an alternative to independent studies. Students will compose their own reading lists and prepare an annotated bibliography and give weekly presentations.

SPANPORT 495-0 Practicum in Scholarly Writing & Publication (1 Unit)
Workshop intended to help students to design, research and write a scholarly article. Required for all graduate students in their second year.

SPANPORT 496-0 Dissertation Prospectus Writing Workshop (1 Unit)
This course seeks to impart to students the knowledge necessary to answer the questions: what is a dissertation, and how do I write one? In the spirit of a workshop, we will work as a group to foster and cultivate the skill sets necessary to formulate and articulate an organizing question adequate to the charge of a significant, independent, multi-year research project. We will call this first stage the prospectus, and we will figure out what it is and how best to write it. We will try to distill multiple and often conflicting statements, expectations, and/or fears about what
the dissertation is so we can effectively undertake its preparation and writing.

SPANPORT 499-0 Independent Study (1 Unit)
Independent reading under supervision. Consultation with director of graduate studies required.

SPANPORT 560-0 Foreign Language Teaching: Theory and Practice (1 Unit)
Current approaches to the teaching of Spanish as a Second Language. This course is designed for students in the graduate program in Spanish and Portuguese who will be teaching Spanish at Northwestern University, and undergraduate students who are planning to become Spanish instructors.

SPANPORT 570-0 Teaching Assistantship and Methodologies (1 Unit)
Tutorial arranged between individual students and faculty and taken on an ungraded basis. May include attendance at advanced undergraduate course lectures and service in teaching assistantships.

SPANPORT 590-0 Research (1-3 Units)
This course is intended for students to conduct preliminary dissertation research while on fellowship.

Statistics (STAT)

STAT 301-1 Data Science 1 (1 Unit)
Series aims to develop the practical skills necessary for conducting data science while surveying foundational analytic methods with a focus on application. Substantial data analysis project required in each course. Data Science 1 focuses on data management, manipulation, and visualization skills and techniques for exploratory data analysis. Prerequisite: STAT 202-0 or equivalent.

STAT 301-2 Data Science 2 (1 Unit)
Series aims to develop the practical skills necessary for conducting data science while surveying foundational analytic methods with a focus on application. Substantial data analysis project required in each course. Data Science 2 focuses on foundational analytic methods such as linear regression, resampling, and tree-based methods. Prerequisite: STAT 301-1 or consent of instructor.

STAT 301-3 Data Science 3 (1 Unit)
Series aims to develop the practical skills necessary for conducting data science while surveying foundational analytic methods with a focus on application. Substantial data analysis project required in each course. Data Science 3 focuses on methods such as support vector machines, clustering, and neural networks. Prerequisite: STAT 301-2 or consent of instructor.

STAT 302-0 Data Visualization (1 Unit)
Introduction to the knowledge, skills, and tools required to visualize data of various formats across statistical domains and to create quality visualizations for both data exploration and presentation. Prerequisite: STAT 202-0 or equivalent.

STAT 320-1 Statistical Theory & Methods 1 (1 Unit)
Sample spaces, computing probabilities, random variables, distribution functions, expected values, variance, correlation, limit theory. May not receive credit for both STAT 320-1 and any of STAT 383-0, MATH 310-1, MATH 311-1, MATH 314-0, MATH 385-0, ELEC_ENG 302-0, or IEMS 202-0. Corequisites: STAT 202-0 or STAT 210-0, MATH 234-0.

STAT 320-2 Statistical Theory & Methods 2 (1 Unit)
Sampling, parameter estimation, confidence intervals, hypothesis tests. Prerequisite: STAT 320-1 or MATH 310-1.

STAT 325-0 Survey Sampling (1 Unit)
Probability sampling, simple random sampling, error estimation, sample size, stratification, systematic sampling, replication methods, ratio and regression estimation, cluster sampling. Prerequisites: MATH 230-1 and 2 quarters of statistics, or consent of instructor.

STAT 328-0 Causal Inference (1 Unit)
Introduction to modern statistical thinking about causal inference. Topics include completely randomized experiments, confounding, ignorability of assignment mechanisms, matching, observational studies, noncompliance, and Bayesian methods. Prerequisites: STAT 320-2, STAT 350-0.

STAT 330-1 Applied Statistics for Research 1 (1 Unit)
First Quarter: Design of experiments and surveys, numerical summaries of data, graphical summaries of data, correlation and regression, probability, sample mean, sample proportion, confidence intervals and tests of significance, one and two sample problems, ANOVA. Second Quarter: Simple linear regression, inference, diagnostics, multiple regression diagnostics, autocorrelation, 1-way ANOVA, power and sample size determination, 2-way ANOVA, ANCOVA, randomized block designs.

STAT 330-2 Applied Statistics for Research 2 (1 Unit)
Second Quarter: Simple linear regression, inference, diagnostics, multiple regression diagnostics, autocorrelation, 1-way ANOVA, power and sample size determination, 2-way ANOVA, ANCOVA, randomized block designs.

STAT 342-0 Statistical Data Mining (1 Unit)
Methods for modeling binary responses with multiple explanatory variables. Potential topics include statistical decision theory, binary regression models, cluster analysis, probabilistic conditional independence, and graphical models. Prerequisites: courses in probability and statistics comparable to STAT 320-1, STAT 320-2; a course in multiple regression comparable to STAT 350-0; familiarity with statistical computing software such as MINITAB or SPSS.

STAT 344-0 Statistical Computing (1 Unit)
Exploration of theory and practice of computational statistics with emphasis on statistical programming in R. Prerequisite: STAT 320-2 or equivalent.

STAT 345-0 Statistical Demography (1 Unit)
Introduction to statistical theory of demographic rates (births, deaths, migration) in multistate setting; statistical models underlying formal demography; analysis of error in demographic forecasting. Prerequisite: STAT 350-0, MATH 240-0, or equivalent.

STAT 348-0 Applied Multivariate Analysis (1 Unit)
Statistical methods for describing and analyzing multivariate data. Principal component analysis, factor analysis, canonical correlation, clustering. Emphasis on statistical and geometric motivation, practical application, and interpretation of results. Prerequisites: STAT 320-2, MATH 240-0.
First Quarter: Distribution theory, characteristic functions, moments and cumulants, random variables, sampling theory, and common statistical distributions. Second Quarter: Methods of estimation, hypothesis tests, confidence intervals, least squares, likelihood methods, and large-sample methods. Third Quarter: Theories of inference, multivariate methods, and contingency tables.

STAT 420-3 Introduction to Statistical Theory & Methodology-3 (1 Unit)
First Quarter: Distribution theory, characteristic functions, moments and cumulants, random variables, sampling theory, and common statistical distributions. Second Quarter: Methods of estimation, hypothesis tests, confidence intervals, least squares, likelihood methods, and large-sample methods. Third Quarter: Theories of inference, multivariate methods, and contingency tables.

STAT 425-0 Sampling Theory and Applications (1 Unit)
Sampling designs (simple random, unequal probability, stratified, cluster, systematic, random walk, induced, multiphase, choosing sample sizes), sample adjustment (weighting/calibration), variance estimation, non-sampling errors, topics re government statistical agencies.
Prerequisites: Two previous courses in probability and statistics, at least one at the 300 level in Statistics (other than STAT 330-1, STAT 330-2), Econometrics, IE/MS, Math; or permission of instructor.

STAT 439-0 Meta-Analysis (1 Unit)
Statistical methods for combining results of replicated experiments. Effect size indexes and their estimators, combined estimation and test of heterogeneity, modeling between-study variation in effect sizes, models for publication selection.
Prerequisite: A graduate-level course in statistics.

STAT 448-0 Multivariate Statistical Methods (1 Unit)
Multivariate normal distribution, Hotelling’s T2-test, multivariate analysis of variance, discriminant analysis, canonical correlation, principal components, and factor analysis. Use of computer packages.

STAT 451-0 Design & Analysis of Social Experiments (1 Unit)
This course covers the design and analysis of social experiments conducted in field settings. It will focus on experiments based on samples from populations with hierarchical structure and experiments that involve randomization of intact groups (statistical clusters) to treatments. Design and analysis considerations will be covered in detail, and students will carry out exercises in the design and analysis of social experiments in realistic settings.
Prerequisite: Permission of the instructor.

STAT 453-0 Survival Analysis (1 Unit)
Life-table construction, Kaplan-Meier estimation, exponential survival distributions, Weibull distributions, and Cox regression models.

STAT 454-0 Time Series Analysis (1 Unit)
Harmonic analysis, power spectra, filtering, cross-spectra, linear processes, and forecasting.

STAT 455-0 Advanced Qualitative Data Analysis (1 Unit)
Probit, logit, log-linear, and latent-class models. Multi-dimensional contingency tables; polytomous responses with continuous independent variables.

STAT 456-0 Generalized Linear Models (1 Unit)
Inference and fitting of generalized linear models with application to classical linear models, binomial and multinomial logit models, log-linear models, Cox’s proportional hazards model and GEE’s for longitudinal data.
Prerequisites: STAT 350-0 and STAT 420-3.

STAT 457-0 Applied Bayesian Inference (1 Unit)
Introduction to computational algorithms for Bayesian inference. Observed data and data augmentation methods are considered in detail. Methods are illustrated with real examples. Prerequisites: STAT 350-0 and STAT 420-1 or equivalent.

**STAT 461-0 Advanced Topics in Statistics (1 Unit)**

**STAT 465-0 Statistical Methods for Bioinformatics and Computational Biology (1 Unit)**
An introduction of statistical methodologies in cutting-edge fields of computational biology and bioinformatics topics including microarray gene expression data analysis; biological sequence analysis; EST and SAGE data analysis.

**STAT 466-0 Likelihood Methods (1 Unit)**
Recent results in the theory of likelihood-based inference. Topics covered will include higher-order asymptotic theory, based both on Edgeworth expansions and saddlepoint methods, conditional and marginal likelihood functions, the modified profile likelihood function and adjustments to the signed likelihood ratio statistic. Prerequisite: STAT 420-2.

**STAT 498-0 Advanced Practicum (1 Unit)**
Supervised statistical consultation.

**STAT 499-0 Independent Study (1-3 Units)**
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

**STAT 519-0 Responsible Conduct of Research Training (0 Unit)**

**STAT 590-0 Research (1-3 Units)**
SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

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**Swahili (SWAHILI)**

**SWAHILI 410-0 Advanced Study (1 Unit)**

**TGS General Registrations (TGS)**

**TGS 370-0 Summer Research Opportunity Program (1 Unit)**
The Graduate School at Northwestern University's Summer Research Opportunity Program (SROP) is a campus-based academic and research experience for outstanding undergraduate students in their sophomore through senior year, who are underrepresented in their field of study. The program is designed to prepare the students for graduate study and careers in academia. Each student participates in a research project that is guided by a faculty mentor, contributing as a member of a research team. The students attend weekly workshops, and professional developments that address issues related to research and graduate education.

**TGS 500-0 Advanced Doctoral Study (0 Unit)**
Available to doctoral students who have completed the residency requirement of eight quarters of full-tuition registration within their program and are receiving aid from the University. Provides full-time status.

**TGS 509-0 Foundations of American English and Academic Culture (0 Unit)**
This non-credit course provides online English language instruction and information on adjusting to life at Northwestern for newly matriculated international graduate students enrolled in the ELP Foundations program.

**TGS 512-0 Continuous Registration (0 Unit)**
Available to students who completed the program coursework and are continuing in their degree program (writing a thesis or dissertation and/or performing research required for the degree), but not receiving University or external funding. TGS 512-0 is a full time registration intended for students who are continuing to work in a full-time capacity toward degree completion.

**TGS 514-0 Continuous Registration Exception (0 Unit)**
Available to students who are enrolled in a dual or joint degree program and are enrolled in the non-TGS portion of the dual/joint program. Requires permission of The Graduate School.

**TGS 515-0 Management for Scientists and Engineers (0 Unit)**
Successful researchers in engineering and the life and physical sciences face daily challenges managing and leading teams, communicating with business-oriented colleagues, and surmounting the hurdles associated with the commercialization of research. But doctoral students in these fields are seldom exposed to these situations before entering academia or industry. To address this gap, The Graduate School partners with Kellogg School of Management to offer a course taught by Kellogg faculty that will equip promising post-candidacy doctoral students with the necessary business and leadership skills.

**TGS 516-0 RSG: Intensive Research Communication (0 Unit)**
Research communication and coaching researchers to improve their own presentation skills by building confidence in all communication roles, enhancing the clarity of the message, and forming a connection with any audience.

**TGS 517-0 Science Writing/Communication (0 Unit)**
Skills & Careers in Science Writing is a graduate-level, 9-week writing and communications course designed for STEM graduate students (PhD track) at Northwestern. The course focuses on techniques and best practices for science writing/communication. Students will learn editorial skills, gain exposure to a breadth of career possibilities, and hone their writing skills through authentic writing and editorial assignments. The course will help STEM PhD trainees write clearly and speak confidently about their own research, providing a solid skills foundation for future pursuits in science writing and communication.

**TGS 518-0 Commercialization in Context (0 Unit)**
This course addresses why, when and how life scientists may secure and leverage the intangible knowledge produced by their research. Case studies involving challenges in big pharma (Lyrica, Naurex etc.) medical devices, health care software, agricultural plant breeding and other life science topics will be explored. The course begins with a survey of various intellectual property forms for inventions, original expressions, source identifiers/brands and confidential information etc. and how same can be used to build a unique selling proposition. Cost effective approaches for registering these intangibles as Intellectual Property (IP) are discussed. Methods for leveraging IP ownership to navigate the obstacles to commercialization will be reviewed.

**TGS 588-0 Resident Masters Study (0 Unit)**
Available to master’s degree students who are receiving financial support administered by the University. Provides full-time status, but allows no accumulation of credit or residency toward the master’s degree. This registration requires The Graduate School’s permission.

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**Theatre & Drama (TH&DRA MA)**

**TH&DRA MA 501-0 Doctoral Studies in Theatre & Drama (1 Unit)**
Introduction to methods, questions, ideas, and resources in theatre and drama scholarship. Seminar with individual research projects. Required of entering students in program; open to students in other departments with permission of instructor.

**TH&DRA MA 502-0 Topics in Theatre (1 Unit)**
The history, theory, or literature of theatre. Course material varies.
Theatre (THEATRE)

THEATRE 310-0 Special Topics in Directing (1 Unit)
Studies with Directing Faculty on special topics related to directing and theatrical forms.
Prerequisite: consent of instructor.

THEATRE 312-0 Text Analysis (1 Unit)
Seminar in analysis of dramatic texts as related to the problems of realized theatrical production.
Prerequisite: consent of instructor.

THEATRE 313-0 History of Directing (1 Unit)

THEATRE 320-0 Special Topics in Theatre Design (1 Unit)

THEATRE 333-2 Advanced Creative Drama (1 Unit)
Explores improvised drama as a teaching method and a means of learning for the elementary school child. Theory and practice through reading, discussion, films, and observation. Course culminates in extended teaching projects with children from local schools.
Prerequisites: THEATRE 333-1 (or equivalent) and consent of instructor.

THEATRE 340-0 Special Topics in Advanced Theatre Studies (1 Unit)
Content varies. Advanced study of individual playwrights, practitioners, regional theatres, historical periods, performance practices, or theoretical inquiries.
Prerequisite: THEATRE 140-1, THEATRE 140-2 or consent of instructor.

THEATRE 341-0 Theatre and Social Change (1 Unit)
Prerequisite: THEATRE 140-1, THEATRE 140-2 or consent of instructor.

THEATRE 342-0 Dramaturgy (1 Unit)
Seminar in creative dramaturgical research as it relates to the problems of realized theatrical production.
Prerequisite: THEATRE 140-1, THEATRE 140-2 or consent of instructor.

THEATRE 343-0 Puppetry History & Performance (1 Unit)
Seminar in the history and theory of puppetry with an emphasis on embodied experimentation.
Prerequisite: THEATRE 140-1, THEATRE 140-2 or consent of instructor.

THEATRE 344-0 Gender & Performance (1 Unit)
Exploration of recent research on the social and political background of gender, particularly women’s access to transformative expressions. Historical aesthetics: changing debates on women’s participation in the public theatre and the significance of the body in performance.

THEATRE 345-0 African American Theatre (1 Unit)
Study of African American playwrights, practitioners, theatre companies, historical performance practices, theoretical inquiries, or transnational influences.
Prerequisite: THEATRE 140-1, THEATRE 140-2 or AF_AM_ST 259-0 or consent of instructor.

THEATRE 346-0 Asian American Theatre (1 Unit)
Study of Asian American playwrights, practitioners, theatre companies, historical performance practices, theoretical inquiries, or transnational influences.

THEATRE 347-0 Latinx Theatre (1 Unit)
Study of Latinx playwrights, practitioners, theatre companies, historical performance practices, theoretical inquiries, or transnational influences.

THEATRE 348-0 Transnational Theatre (1 Unit)
Study of the history, theory, or literature of transnational theatre and other theatrical forms.

THEATRE 357-0 Orchestration (1 Unit)

THEATRE 376-0 Intro to Acting for the Screen (1 Unit)

THEATRE 402-0 Graduate Colloquium (1 Unit)
Advanced graduate study. Topics vary with instructor.

THEATRE 420-1 Collaboration: American Realism (1 Unit)
First in a series exploring collaboration between stage director and designers for production. Focus: collaborative process; realistic and naturalistic American drama.
Prerequisites: Permission of instructor.

THEATRE 420-2 Collaboration: Contemporary Drama (1 Unit)
Second in a series exploring collaboration between stage director and designers for production. Focus: contemporary drama.
Prerequisites: THEATRE 420-1 and permission of instructor.

THEATRE 420-3 Collaboration: Shakespeare in the 21st Century (1 Unit)
Third in a series exploring collaboration between stage director and designers for production. Focus: Shakespeare.
Prerequisites: THEATRE 420-1, THEATRE 420-2, and permission of instructor.

THEATRE 434-0 Workshop in Drama-Oriented Teaching Techniques (1 Unit)
Content varies; focuses on the origins and practice of storytelling, theatre games, and story theatre. Summer only.

THEATRE 440-0 Studies in Comparative Theatre & Drama (1 Unit)
One aspect of the drama and theatre before the modern period.

THEATRE 441-0 Studies in Modern Theatre & Drama (1 Unit)
One aspect of the modern theatre movement, a dramatist, or type of drama.

THEATRE 442-0 Theatre Practice (1 Unit)

THEATRE 444-0 Dramatic Criticism (1 Unit)
Principles of dramatic criticism from Aristotle to the present. Critical standards and methods and their application to the evaluation of drama in performance.

THEATRE 445-3 History of Western Theatrical Practice (1 Unit)
History and theory of theatre and drama.

THEATRE 448-0 Studies in American Theatre and Drama (1 Unit)
Intensive study of one aspect of American theatre and drama, such as political theatre, Chicago theatre, American drama and the American dream, or the history of acting in America.

THEATRE 450-0 Topics in Stage Design (1 Unit)
Seminars with guest or resident faculty on advanced topics in theatre design; intended primarily for graduate design students.
Prerequisites: Permission of instructor.

THEATRE 451-1 Seminar in Advanced Directing (1 Unit)
Seminar in advanced directorial topics; required of graduate students in the MFA program in directing.

THEATRE 451-2 Seminar in Advanced Directing (1 Unit)
Seminar in advanced directorial topics; required of graduate students in the MFA program in directing.

THEATRE 451-3 Seminar in Advanced Directing (1 Unit)
Seminar in advanced directorial topics; required of graduate students in the MFA program in directing.

THEATRE 462-1 Advanced Studies in Lighting Design (1 Unit)
Primarily for graduate lighting design students. Students develop lighting ideas and images based on text analysis and production parameters and explore graphic means of communicating their ideas and images.
Prerequisites: Permission of instructor.

THEATRE 462-2 Advanced Studies in Lighting Design (1 Unit)
Primarily for graduate lighting design students. Students implement lighting ideas and images through light plots. Photometrics and technical knowledge and skills emphasized.
Prerequisites: THEATRE 462-1 and permission of instructor.

THEATRE 462-3 Advanced Studies in Lighting Design (1 Unit)
Primarily for graduate lighting design students. Special topics are addressed through a paradigm of master classes, workshops, lecture demonstrations, and projects.
Prerequisites: THEATRE 462-1, THEATRE 462-2, and permission of instructor.

THEATRE 463-1 Advanced Studies in Scenic Design (1 Unit)
Script and the action of the play as the foundation for scene design. Use of initial reading of the script, combined with research, in forming design ideas.
Prerequisites: Permission of instructor.

THEATRE 463-2 Advanced Studies in Scenic Design (1 Unit)
Students apply drawing, painting, modeling and drafting skills developed in THEATRE 463-1 to create a mature design presentation that expresses their ideas clearly.
Prerequisites: THEATRE 463-1 and permission of instructor.

THEATRE 463-3 Advanced Studies in Scenic Design (1 Unit)
Using the process developed in THEATRE 463-1 and THEATRE 463-2, students generate a complete, professional scenic design for a major work of drama, including a fully documented package.
Prerequisites: THEATRE 464-1, THEATRE 464-2, and permission of instructor.

THEATRE 464-1 Advanced Studies in Costume Design (1 Unit)
Individual design process, involving text interpretation, character analysis, and research, in response to texts of various theatrical genres.
Prerequisites: Permission of instructor.

THEATRE 464-2 Advanced Studies in Costume Design (1 Unit)
Students apply costume design processes developed in THEATRE 464-1 to the interpretation of traditional and non-traditional text.
Prerequisites: THEATRE 464-1 and permission of instructor.

THEATRE 464-3 Advanced Studies in Costume Design (1 Unit)
Using the processes developed in THEATRE 464-1 and Theatre 464-2, students generate a professional level costume design for a major work of drama. Texts may be in verse or operatic form.
Prerequisites: THEATRE 464-1, THEATRE 464-2, and permission of instructor.

THEATRE 470-2 Acting 2: Contemporary Drama and Attacking the Scene (1 Unit)
This section of acting class will build on the text work and character creation from the first section while continuing to grow and deepen the physical creative processes discovered in the fall. This course will focus on contemporary scripts whose structure may prove more elusive and activate multiple-character ensemble work. Continuing to focus on script analysis and given circumstances, students will learn how to read modern work for context and theme and how to find the characters within the plays that serve both. Writers may include Suzan-Lori Parks, Tarell Alvin McCraney, Young Jean Lee, Will Eno and Karen Zacarias. This course meets four times per week for three hours and students can expect to have 10 hours of out-of-class work per week.

THEATRE 470-3 Acting 3: Shakespeare 1 (1 Unit)
First Year Acting MFAs will begin the practice of analyzing Shakespeare’s text with basic scansion through an in-depth study of sonnets and monologues. This course will meet two days per week for three hours.

THEATRE 471-1 Movement 1: Presence (1 Unit)
Movement I will explore contemporary physical training techniques for actors with the intention of preparing the body for advanced creative practice. This course will establish techniques for addressing our physical needs first as people, then as artists, and finally as a character. This class meets five days a week for two hours per session.

THEATRE 471-2 Movement 2: Research (1 Unit)
Movement II will delve into individualized actor research, integrating the practices of physical training, creative movement, and performance research—the development of physical actions for a role or performance. The intention of this course is to cultivate the actor’s self-confidence and self-reliance in the articulation of physical inquiries and the subsequent development of relevant physical training and performance material. The ensemble will continue to practice group exercises established in the first semester that increase articulation, agility, core strength and partnership.

THEATRE 471-3 Movement 3: Integration/Practice (1 Unit)
Movement III, the final course of the first year movement series, will focus on the integration of physical training, personal research, and creative movement into a dedicated ensemble performance practice. The actors will cultivate the vitality and excellence of the entire ensemble, and each actor will be asked to sustain their individual training inquiries and sense of self within a rigorous group practice.

THEATRE 472-1 Voice 1 (1 Unit)
This first quarter course focuses on physical awareness, relaxation and freeing. Students are introduced to the sounds of English and the American Stage Standard dialect through the use of the International Phonetic Alphabet as they work to develop their voices for stage performance. Students will perform selections of contemporary poetry in solo and group pieces from a variety of poets. This course meets twice a week for two hour per session.

THEATRE 472-2 Voice 2 (1 Unit)
The second quarter of voice builds on the foundation of the first. The work will focus on Shakespeare’s works including sonnets, monologues suitable for auditions and scene work. This course meets twice a week for two hour sessions.

THEATRE 472-3 Voice 3 (1 Unit)
This class will explore the use of the voice in plays that demand highly skilled use of language including dialect work from some of these plays, which may include American Stage Standard and RP as well as other dialects from the UK, Europe, Africa and the United States.

THEATRE 499-0 Independent Study (1 Unit)
Content varies. May be repeated for credit with change of topic. Permission of instructor and department required. SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

THEATRE 545-0 Seminar-Studies in Drama (1 Unit)
Content varies. May be repeated for credit with change of topic.

THEATRE 546-0 Seminar-Studies in Theatre (1 Unit)
Content varies. May be repeated for credit with change of topic.

THEATRE 590-0 Research (1-3 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit. SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

Turkish (TURKISH)

TURKISH 410-0 Advanced Study (1 Unit)
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