BULLETIN • GRADUATE PROGRAMS • 2016–2017

ILLINOIS INSTITUTE
OF TECHNOLOGY

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FOREWORD

Purpose of the Illinois Institute of Technology Graduate Bulletin

This bulletin describes the academic programs and resources, policies, procedures, and student services in effect at the time of publication. It serves as a primary source of information for graduate students, faculty, and administration. Prospective students and others can also use these sections to gain an understanding of the university—its history, its campus setting, its campus life, etc.,—as a whole.

The programs described in this bulletin are applicable to those students who enter Illinois Institute of Technology (IIT) in the academic year 2016-2017. Students follow the programs described in the bulletin in effect at the time of their first registration.

Changes in programs and policies often occur before a new bulletin is published. A faculty adviser from the student's major department is the best source for current curriculum information. Updates are also listed on web.iit.edu/gaa. The Office of Graduate Academic Affairs can also refer students to the appropriate administrative office for current policies and procedures.

Illinois Institute of Technology is a multicultural community that values and respects its members. We take pride in the fact that our faculty, staff, and students come from various backgrounds and all parts of the world, and we welcome their diverse perspectives and contributions. It is our policy to provide a working and learning environment in which faculty, staff, and students are able to realize their full potential as productive members of the university community.

To this end, Illinois Institute of Technology affirms its commitment to equal opportunity and nondiscrimination in employment and education for all qualified individuals regardless of race, religion, color, national origin, gender, age, sexual orientation, gender identity, disability, applicable veteran status, or any other characteristic protected by applicable federal, state, or local law. Further, the university is committed to taking affirmative action to increase opportunities at all levels of employment and to increase opportunities for participation in programs and activities by all faculty, staff, and students.

Every member of the Illinois Institute of Technology community: faculty, staff, and student, is expected to cooperate fully in meeting these goals.

Any student, applicant, or employee of Illinois Institute of Technology who believes that he or she has received inequitable treatment because of discrimination violating the university's stated policy of equal opportunity in employment and in education should communicate, either in writing or in person, with the Director, Equal Employment Opportunity and Affirmative Action, IIT Tower, Illinois Institute of Technology.

Note: The information in this bulletin is subject to change without notice.

Illinois Institute of Technology
Graduate College
10 W. 35th St., Suite 7D7-1
Chicago, IL 60616-3793

UNIVERSITY OVERVIEW

Objective of Graduate Education at Illinois Institute of Technology

To provide post-baccalaureate education and research programs that enhance students' fundamental knowledge of their chosen field.

To educate and mentor graduate students to function in a global community with an appreciation of the economic, environmental, and social forces that impact professional choices.

To strengthen Illinois Institute of Technology's leadership role in higher education by focusing on the core research competencies and enhancing partnerships with industry, government laboratories, and academic and research institutions.

Accreditation

Illinois Institute of Technology is accredited by the Higher Learning Commission (hlcommission.org).

Specific professional curricula are accredited by the Engineering Accreditation Commission and the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology, American Psychological Association, Council on Rehabilitation Education, American Bar Association, Association of American Law Schools, The Association to Advance Collegiate Schools of Business, and National Architectural Accrediting Board.

Administration and Colleges

Board of Trustees (web.iit.edu/president/board-trustees)

Alan W. Cramb, President
Office of the President (web.iit.edu/president)

Frances Bronet, Provost and Senior Vice President for Academic Affairs
Office of the Provost (web.iit.edu/provost)

Wiel Arets, Dean, College of Architecture

Russell Betts, Dean, College of Science

John Bilson, Dean, Stuart School of Business

C. Robert Carlson, Dean, School of Applied Technology

Natacha DePaola, Dean, Armour College of Engineering

Christine Himes, Dean, Lewis College of Human Sciences

Harold Krent, Dean, Chicago-Kent College of Law

Academic Calendar

Website: web.iit.edu/registrar/academic-calendar

The official academic calendar for Illinois Institute of Technology, including dates for class registration, final exams, midterm and final grades, and degree conferral, is located on the Office of the Registrar's website.

Division of Academic Affairs

Website: web.iit.edu/academic-affairs

Christopher White, Vice Provost for Research and Academic Affairs

The division of Academic Affairs falls under the leadership of the Vice Provost for Research and Academic Affairs, Dr. Christopher White. As vice provost, Dr. White is responsible for Undergraduate and Graduate Academic Affairs, the Graduate College, the Academic Resource Center (ARC), Office of Undergraduate Research, the Interprofessional Projects (IPRO) Program, the Idea Shop, Assessment and Accreditation, and student academic affairs in general. The services provided by the offices overseen by Dr. White enhance the educational experience of both graduate and undergraduate students.

Graduate College

Website: web.iit.edu/gaa

Jamshid Mohammadi, Associate Dean of the Graduate College
Holli Pryor-Harris, Associate Vice Provost, Graduate Academic Affairs

The Graduate College coordinates the programs of advanced study offered by the academic units of the university. The Associate Dean chairs the Graduate Studies Committee, sets minimum standards for graduate students, represents the university in national forums for graduate education, serves as an advocate for promoting graduate education across the university, and oversees thesis examination through the Director of Academic Writing.

The Office of Graduate Academic Affairs, headed by the Associate Vice Provost, monitors academic progress, conducts academic standing reviews, completes preliminary and final academic audits, certifies and awards degrees, and enforces co-terminal and graduate studies policies.

Thirty-five separate Master of Science (M.S.) degrees, which typically include a thesis requirement, are offered. The professional Master's (MAS) and Master of Engineering (M.E.) degrees, which do not require a thesis, have fifty separate offerings. Doctoral (Ph.D.) degrees are offered in twenty-three fields.

Research

Faculty and students engage in research across a range of disciplines through institutes, centers, and programs as represented by those described below. More information is available on the Research @ IIT website (research.iit.edu).

Research Institutes

IIT Research Institute (IITRI)
The Institute for Food Safety and Health
The Pritzker Institute of Biomedical Science and Engineering
Wanger Institute for Sustainable Energy Research (WISER)

Research Centers

The Center for Accelerator and Particle Physics (CAPP)
Center for Complex Systems and Dynamics (CCSD)
Center for Electrochemical Science and Engineering
Center of Excellence in Polymer Science & Engineering (CEPSE)
The Center for Financial Innovation
Center for Integrative Neuroscience and Neuroengineering Research
Center for Molecular Study of Condensed Soft Matter
Center for Nutrition Research
Center for Processing Innovation
Center for Specialty Programs
The Center for Strategic Competitiveness (CSC)
Center for the Study of Ethics in the Professions (CSEP)
Center for Synchrotron Radiation Research and Instrumentation
Center for Work Zone Safety and Mobility (CWZSM)
Electric Power and Power Electronics Center (EPPEC)
Engineering Center for Diabetes Research and Education (ECDRE)
Fluid Dynamics Research Center
Illinois Institute of Technology Architecture Chicago Research Center (IITAC-Research Center)
International Center for Sensor Science and Engineering (ICSSE)

Medical Imaging Research Center (MIRC)
National Center for Food Safety and Technology
Robert W. Galvin Center for Electricity Innovation
Thermal Processing Technology Center (TPTC)
Wireless Network and Communications Research Center (WiNCom)

Service, Education, and Outreach Centers

Energy/Environment/Economics (E3)
The Center for Research and Service
The Center for Sustainable Enterprise
Grainger Power Engineering Laboratory (GPEL)
Institute for Science, Law & Technology
The Invention Center
The Office of Intellectual Property and Technology Transfer

Illinois Institute of Technology History and Campuses

In 1890, when advanced education was often reserved for society's elite, Chicago minister Frank Wakely Gunsaulus delivered what came to be known as the "Million Dollar Sermon." From the pulpit of his South Side church, near the site Illinois Institute of Technology now occupies, Gunsaulus said that with a million dollars he could build a school where students of all backgrounds could prepare for meaningful roles in a changing industrial society.

Inspired by Gunsaulus's vision, Philip Danforth Armour Sr. (1832–1901) gave $1 million to found Armour Institute. Armour, his wife, Malvina Belle Ogden Armour (1842–1927), and their son J. (Jonathan) Ogden Armour (1863–1927) continued to support the university in its early years. When Armour Institute opened in 1893, it offered professional courses in engineering, chemistry, architecture, and library science.

Illinois Tech was created in 1940 by the merger of Armour Institute and Lewis Institute. Located on the west side of Chicago, Lewis Institute, established in 1895 by the estate of hardware merchant and investor Allen C. Lewis, offered liberal arts as well as science and engineering courses for both men and women. At separate meetings held by their respective boards on October 26, 1939, the trustees of Armour and Lewis voted to merge the two colleges. A Cook County circuit court decision on April 23, 1940 solidified the merger.

The Institute of Design (ID), founded in Chicago by Làszlò Moholy-Nagy in 1937, merged with Illinois Tech in 1949.

Chicago-Kent College of Law, founded in 1887, became part of the university in 1969, making Illinois Institute of Technology one of the few technology-based universities with a law school.

Also in 1969, Stuart School of Management and Finance—now known as Stuart School of Business—was established thanks to a gift from the estate of Lewis Institute alumnus and Chicago financier Harold Leonard Stuart. The program became Stuart School of Business in 1999.

The Midwest College of Engineering, founded in 1967, joined the university in 1986, giving Illinois Tech a presence in west suburban Wheaton with what is today known as the Rice Campus—home to Illinois Tech's School of Applied Technology.

In December 2006 University Technology Park at Illinois Institute of Technology, an incubator and life sciences/tech startup facility, was started in existing research buildings located on the south end of Mies Campus. University Tech Park at Illinois Institute of Technology is now home to many companies.

Today, Illinois Tech is a private, Ph.D.-granting research university with programs in engineering, science, human sciences, applied technology, architecture, business, design, and law. One of the 21 institutions that comprise the Association of Independent Technological Universities (AITU), Illinois Tech offers exceptional preparation for professions that require technological sophistication. Through a committed faculty and close personal attention, Illinois Tech provides a challenging academic program focused by the rigor of the real world.

The university has five campuses in the Chicago area. The 120-acre Mies Campus, centered at 33rd and State streets in Chicago, as well as many of its buildings, were designed by Ludwig Mies van der Rohe, who directed the architecture program at Illinois Tech from 1938–1958 and was one of the twentieth century's most influential architects. S. R. Crown Hall, home of Illinois Tech College of Architecture, was named a National Historic Landmark in 2001, and part of the Illinois Tech Mies Campus was entered into the National Register of Historic Places in 2005.

Chicago and Its Environs

Chicago is world renowned for its museums and architecture, and offers exceptional career and internship opportunities in all of Illinois Tech's fields of study. The city and its surroundings form an international center of finance and law, a manufacturing and transportation hub, and the home of two national research laboratories (Argonne National Laboratory and Fermi National Accelerator Laboratory), as well as numerous medical facilities and corporate headquarters.

Diversions range from a world-class symphony orchestra to major league sports teams. Located on the southwestern shore of Lake Michigan, Chicago boasts miles of attractive beaches and parks for jogging, biking, swimming, and boating. Ethnic neighborhoods throughout the city provide an international array of cultures and cuisine. Chicago is also rich in live theater, and music clubs abound.

Student Demographics

A Snapshot of the Illinois Institute of Technology Community

Demographic Type	Data
Enrollment (Fall 2015)	
Undergraduate	2,991 students
Graduate	3,910 students
Law	891 students
Total	**7,792 students**

Demographic Type	Data
Student Demographics	
Male	66%
Female	34%
Minority[1]	13%
International	50%
Countries of Origin	100
Student/Faculty Ratio	13:1

Demographic Type	Data
Degrees Awarded 2014-2015	
Bachelor	587
Master	1,583
First Professional	278
Ph.D.	86
Total	**2,534**

[1] Minorities include domestic students with the following ethnicities: Black or African American, Hispanic/Latino of any race, American Indian or Alaskan Native, Two or more races.

GRADUATE ADMISSION

Application for Admission

Application information and forms for degree and non-degree admission may be accessed by visiting admissions.iit.edu/graduate.

All documents submitted in support of an application must be the original. Documents may not be duplicated, transferred, forwarded or returned once they have been submitted to the university. A non-refundable application/processing fee must accompany the application. Students will find current application fees, applications, and instructions at admissions.iit.edu/graduate. Students applying to Stuart School of Business, Chicago-Kent College of Law, Institute of Design, Department of Psychology, and College of Architecture should visit their respective websites for information. Any applicant or student who has attended the university previously is not required to submit an additional application fee.

Students who do not register for the semester they originally applied for must contact the Office of Graduate Admission and request to defer their admission for up to one year. Deferral requests may be submitted to gradstu@iit.edu. Transcripts must be submitted for all courses attempted at other institutions. Students wishing to register more than one year after the initial application must apply as a new student and resubmit all documents and fees.

Applications and information for graduate programs in business may be obtained from Stuart School of Business by visiting stuart.iit.edu/.

Applications for programs in law may be obtained from Chicago-Kent College of Law by visiting kentlaw.iit.edu, by calling 312.906.5020, or by writing to the college at 565 W. Adams, Chicago, IL 60661.

Applications for the College of Architecture are available by visiting arch.iit.edu or by phoning 312.567.3260. The college's mailing address is Crown Hall, 3360 S. State, Chicago, IL 60616.

Degree-Seeking Versus Non-Degree Status

A degree-seeking student is a registered student who submitted an application for admission as a degree-seeking student, was accepted by an academic unit in a specific degree program, and received a formal letter of admission. Degree-seeking students are required to register every semester except summer unless they receive special permission in writing for a leave of absence from the Office of Graduate Academic Affairs.

A non-degree student is a registered student who holds an undergraduate degree from an accredited institution, submitted an application for admission as a non-degree student, and was admitted. Non-degree students are those who wish to improve their professional or personal development without being required to fulfill degree requirements, are not certain about their prospective field of study, have less than a 3.0/4.0 undergraduate GPA, or are unable to submit a completed regular application prior to the beginning of the semester. Non-degree students are not accepted into a graduate degree program and are not classified as degree-seeking students. (See below for procedures on becoming a degree-seeking student.)

Admission as a Degree-Seeking Student

To apply, please submit an application, including all supporting documents and application fee, prior to the published deadlines. Applications received after the specified dates will be considered only if circumstances permit. In addition to the application form, the applicant must submit the following:

1. Official transcripts of all academic work at the college level or above
2. Professional statement
3. Required test scores
4. Letters of recommendation
5. Application fee

All applicants are required to submit GRE general test scores. A minimum score of 292 (quantitative + verbal) and 2.5 (analytical writing) is required for M.S. and professional master's degree applicants. Ph.D. applicants must meet the minimum requirements of 298 (quantitative + verbal) and 3.0 (analytical writing). Individual departments, colleges, and institutes may require higher scores. Students should see the specific admissions requirements listed for each academic unit in the relevant sections of this bulletin. GRE scores may be no more than five-years old.

The Illinois Institute of Technology code number is 1318. The GRE requirement may be waived for applicants to professional master's degree programs who hold bachelor's degrees from an accredited degree program at a U.S. college or university with a cumulative GPA of 3.0/4.0 or higher. The required minimum cumulative undergraduate GPA for regular admission is 3.0/4.0. Students with a 2.5/4.0 GPA may be admitted as non-degree students with a probationary status (see Admission as a Non-Degree Student (p. 13).) Applicants to Chicago-Kent College of Law must submit LSAT scores and other documentation as required by the law school. Stuart School of Business applicants are required to submit GMAT or GRE and other documentation as required by the business school. Prospective students can obtain more information about admission requirements for Chicago-Kent College of Law at kentlaw.iit.edu/ and for Stuart School of Business at stuart.iit.edu.

Meeting the minimum required test scores and GPA does not guarantee admission. Specific requirements and factors considered by academic units in admission decisions for specific degree programs are outlined in the relevant sections of this bulletin.

Admission as a Certificate Student

Admission as a certificate student requires that the student submit the online application form and official transcripts of all college-level coursework. A certificate student must possess a bachelor's degree with a cumulative GPA of 2.5/4.0. A certificate student whose bachelor's degree(s) is not in the field of certificate study or a closely related field may be required to take additional prerequisite courses that may not count toward the certificate. Certificate students are permitted to enroll in as many credit hours as are necessary to complete the certificate.

Certificate students who later apply and are admitted to a master's degree program may apply only approved certificate coursework with a grade of B or better to the master's degree.

Citizens and permanent residents of the United States may apply as a non-degree student under the following classifications:

1. Applicants with incomplete degree seeking applications; who have a minimum undergraduate GPA of 2.5/4.0; or who cannot submit required documentation by the application deadline; or who are undecided on their long-term status or degree program.

   A final degree-seeking admission decision may be deferred until the requisite GPA has been achieved in study as a non-degree student, or until the required documents are submitted. Non-degree students seeking to convert to degree-seeking status must complete a regular online application to a degree program prior to the completion of nine credit hours of study. If a non-degree student applies for and is granted admission to a degree program, a maximum of nine credit hours of approved coursework taken as non-degree student and passed with a grade of B or better may be applied to the degree.
2. Applicants that must complete specific prerequisite courses prior to consideration of admission to a degree-seeking program. Courses taken in this classification are not counted toward degree requirements.
3. Applicants that do not intend to acquire a graduate degree in any specific discipline and wish to enroll in a variety of courses. Students may not pursue or earn a graduate certificate or degree while admitted in this status. Course credits earned are for continuing professional education.

The Office of Graduate Admission will notify non-degree students of the conditions under which they are admitted. Students should also refer to the section on Transfer Credit (p. 476).

International students on an F-1 visa cannot be admitted as non-degree students in any classification.

Admission as a Non-Degree Student

Citizens and permanent residents of the United States may apply as a non-degree student under the following classifications:

1. Applicants with incomplete degree seeking applications; who have a minimum undergraduate GPA of 2.5/4.0; or who cannot submit required documentation by the application deadline; or who are undecided on their long-term status or degree program.

   A final degree-seeking admission decision may be deferred until the requisite GPA has been achieved in study as a non-degree student, or until the required documents are submitted. Non-degree students seeking to convert to degree-seeking status must complete a regular online application to a degree program prior to the completion of nine credit hours of study. If a non-degree student applies for and is granted admission to a degree program, a maximum of nine credit hours of approved coursework taken as non-degree student and passed with a grade of B or better may be applied to the degree.
2. Applicants that must complete specific prerequisite courses prior to consideration of admission to a degree-seeking program. Courses taken in this classification are not counted toward degree requirements.
3. Applicants that do not intend to acquire a graduate degree in any specific discipline and wish to enroll in a variety of courses. Students may not pursue or earn a graduate certificate or degree while admitted in this status. Course credits earned are for continuing professional education.

The Office of Graduate Admission will notify non-degree students of the conditions under which they are admitted. Students should also refer to the section on Transfer Credit (p. 476).

International students on an F-1 visa cannot be admitted as non-degree students in any classification.

International Applicant Requirements

General Requirements

International applications are incomplete until the following are received:

1. Application fee
2. English proficiency test scores (TOEFL, IELTS, or PTE, if required)
3. GRE scores
4. Official transcripts of all academic work at the university level or above
5. Professional statement and portfolio (if required)
6. Two letters of recommendation (three for Ph.D. applicants)

If any of these documents are not in English, the student must provide a certified English translation by a qualified translator, together with the original certified non-English credentials. A minimum GRE score of 292 (quantitative + verbal) and 2.5 (analytical writing) is required for M.S. and professional master's applicants.

Ph.D. applicants must meet the minimum GRE requirements of 298 (quantitative + verbal) and 3.0 (analytical writing). Individual departments, colleges and institutes may require higher scores. Students should see the specific admissions requirements listed for each academic unit in the relevant sections of this bulletin. GRE scores may be no more than five years old.

Certification of Official Transcripts

Completion of graduate studies and conferral of the higher degree requires degree-seeking admission to Illinois Institute of Technology (IIT), and prior completion of the prerequisite degree requirement, as outlined in the current Bulletin: Graduate Programs. Admitted graduate students are required to have earned the prerequisite degree(s) prior to enrollment in the first semester, and to present certification of the earned degree(s) during that semester. Students with an earned degree from IIT, or prior college-level work at IIT, may be exempted from the degree certification policy at the discretion of the Office of Graduate Admission.

Degree certification will be completed during the first semester of enrollment. The student is responsible for requesting all required official documents and services and for the associated costs. The university reserves the right to deny degree conferral to any student who fails to provide the required certification of official documents as outlined. In all cases, a student may not directly submit official documents to satisfy the degree certification requirement.

Master's degree students with an earned baccalaureate degree from an accredited U.S. Institution of Higher Learning: Verification of the baccalaureate degree will be satisfied by the submission of the official certified transcript for the earned degree, sent directly from the institution conferring the degree to the university's Office of Graduate Admission during the first semester of enrollment.

Master's degree students with an earned baccalaureate degree from a foreign institution of higher learning: Verification of the baccalaureate degree will be initiated by the submission of the required documents (and English translations), sent directly from the institution(s) conferring the degree(s) to the accepted international credential evaluation service (and English translation service as required). Credential certification will be satisfied when an affirmative report of the earned degree is received by the university from the accepted international credential evaluation service. Visit the Office of Graduate Admission website (admissions.iit.edu/graduate) for details on submitting the official documents to an accepted international credential evaluation service.

Doctoral students with master's-level and/or baccalaureate degree(s) from an accredited U.S. Institution of Higher Learning: Verification of all earned degrees will be satisfied by the submission of the official certified transcript, for each earned degree, sent directly from the institution conferring the degree(s) to the Office of Graduate Admission (admissions.iit.edu/graduate) during the first semester of enrollment at the university.

Doctoral students with master's-level and/or baccalaureate degrees from a foreign institution of higher learning: Verification of all earned degrees will be initiated by the submission of the official required documents (and English translations), sent directly from the institution(s) conferring the degree(s) to the accepted international credential evaluation service (and English translation service as required). Credential certification will be satisfied when an affirmative report of the earned degree(s) is received by the university from the accepted international credential evaluation service. Visit the Office of Graduate Admission website: admissions.iit.edu/graduate for details on submitting the official documents to an accepted international credential evaluation service.

Failure to provide the required certification of the earned degree(s) will prevent degree conferral. Should the review of official documents fail authentication, the student will be dismissed from graduate study at the university.

For any questions regarding the submission and/or certification of official transcripts, please contact the Office of Graduate Admission (admissions.iit.edu/graduate).

English Competency

Non-native English speakers must prove proficiency in English by submitting a TOEFL (Test of English as a Foreign Language), IELTS (International English Language Testing System), or PTE (Pearson's Test of English) score. The minimum total and section scores for each examination are listed in the table below.

Examination	Minimum Total Score	Minimum Section Score
TOEFL	90	20
IELTS	6.5	5.5
PTE	47	53

Applicants with any section score (or total score) which fails to meet the minimum values listed above will be required to take one or more English courses as determined by an assessment test administered during orientation week. Students are required to take the first of any such necessary courses during the first regular semester of enrollment. Applicants with four or more years of undergraduate education in English as the medium of instruction will be exempt from the TOEFL, IELTS, or PTE requirement, and any English courses.

By accepting admission to the university, students agree to take any additional English courses the Graduate College deems necessary in accordance with the English assessment test. Students whose TOEFL, IELTS, or PTE and assessment test scores indicate they must take two or three English courses will have the opportunity to take an Illinois Institute of Technology English exam near the end of their first course to determine whether their English has improved enough to exempt them from the additional course(s). This exam is administered to all students with TOEFL deficiency prior to the first semester of registration and upon arrival by the Office of Professional Development (OPD).

Applicants should have the official test results sent from the appropriate testing agency to the below address:

Office of Graduate Admission
Illinois Institute of Technology
10 W. 33rd Street, Room 203
Chicago, Illinois 60616

The Illinois Institute of Technology school code number is 1318.

Financial Support

Institutional funds available to assist international students are limited and are usually awarded to a small number of selected students with outstanding academic credentials. Applicants on F-1 student visas are not eligible for part-time employment during their first year of enrollment. International students must provide a certified financial affidavit from a responsible government official, or an official of a recognized financial institution, certifying that the student has (or will have available) funds to cover their entire period of study at the university, and that the funds are free from restrictions and immediately available to cover a period equivalent to one calendar year. The I-20 or DS-2019 cannot be issued until an acceptable affidavit of financial support is received. Additional funds will be needed for travel expenses. Simple statements from parents or relatives to pay all expenses are not acceptable. Bank statements are not acceptable unless accompanied by a certified statement that the funds may be transferred to the United States for the student's use. Documents must be dated within six months of the student's beginning date.

All credentials for international students should be received by the published deadlines. Completion of applications after that date may not allow time for a decision to be made and/or a visa to be issued for the semester requested. It is also helpful for applicants to submit a copy of their passport with their application materials to verify accuracy of the applicant's name. Applicants are warned not to make definite arrangements for attending the university until they have received a formal notice of admission. Students will be advised of their admission decision as soon as possible after the university's receipt of all credentials, usually within six weeks.

Readmission for a Second Graduate Degree

A student who earns a graduate degree at Illinois Institute of Technology is not automatically accepted as a student in a second-degree program in either the same or a different academic unit.

Continuation for a second degree is contingent upon admission in the second program. Additional information is available from the Office of Graduate Admission.

Newly Admitted Students

Accompanying the admission letter will be a website link to the Intent to Enroll form, housing information, initial registration instructions, medical examination form, and an immunization form. For international students the admission packet will include the I-20 or DS-2019 and a link to the Graduate Student Handbook. To register in the semester for which they were admitted, students must return the completed medical form and immunization form.

Arrangements for campus housing must be made directly with the below office:

Director of Housing
Illinois Institute of Technology
3303 S. State St.
Chicago, IL 60616
phone: 312.567.5075 or email housing1@iit.edu

Admission does not include commitments for room and board. A cash deposit is required with the application for housing. In general, the university cannot provide housing assistance for students who wish to live off-campus.

Newly admitted students should consult their academic units concerning program, degree requirements and special departmental regulations, and should make every effort to arrive at the university in time for the initial registration advising date. If students cannot arrive before the last day of late registration, the Office of Graduate Admission must be notified at gradstu@iit.edu.

Enrollment Confirmation and Deferral Requests

At the time of admission, the student should submit a non-binding Intent to Enroll Form in the applicant portal to reserve a place in the program. All students who wish to defer their enrollment to the subsequent semester must request the deferment by contacting the Office of Graduate Admission (gradstu@iit.edu, 312.567.3020). International students may be required to submit a new bank statement.

Immunization Requirement

In accordance with Illinois law, all students born on or after January 1, 1957 and enrolling at Illinois Institute of Technology for the first time after July 1, 1989, must supply health provider-documented evidence of vaccination for diphtheria, tetanus, measles, rubella, and mumps. Transfer students are considered as first-time enrolled students. Students enrolling for the first time during a summer session may be permitted to enroll in the subsequent fall semester before providing proof of immunity. Students who wish to enroll only in one class per semester or via IITV at corporate sites may file a written request for an exemption. Exemption from one or more of the specific requirements may also be granted based on documented medical or religious reasons. A student who fails to provide acceptable evidence of immunity shall be prevented from registering for classes in the next semester. Individuals who are not properly immunized or who do not have proof of immunization may receive the required immunizations at the Student Health and Wellness Center for a nominal fee. The Certification of Immunization form is available at iit.edu/shwc/immunizations. Questions regarding this policy should be directed to:

Student Health and Wellness Center
Illinois Institute of Technology
IIT Tower, Suite 3D9-1

10 W. 35th St.
Chicago, IL 60616
312.567.7550 or student.health@iit.edu

FINANCIAL INFORMATION

Financial Aid

Website: web.iit.edu/financial-aid

Illinois Institute of Technology's Office of Financial Aid provides financial assistance for students and families.

Comprehensive Financial Aid Program

Illinois Institute of Technology administers a comprehensive financial aid program which includes federal, institutional, and private funds for both full- and part-time students. Federal programs include loans and work-study employment. The university uses the formula established by the U.S. Congress to determine financial need for assistance. The university offers limited academic scholarship assistance to graduate students. These scholarships are awarded by individual university departments and by the Office of Graduate Admission. Private loans are also available and are based on credit approval from the lender.

For the most up-to-date information, visit the Office of Financial Aid website.

Student Eligibility Requirements to Receive Federal Financial Assistance

Students must be U.S. citizens or eligible non-citizens, be enrolled in a degree-seeking program at least half-time (4.5 credit hours or more per semester), and demonstrate academic progress towards graduation to qualify for federal aid. Satisfactory academic progress (SAP) includes a minimum grade point average and sufficient credit hours earned each semester towards the completion of a degree program. The university has an established SAP policy in compliance with federal and state regulations. Failure to comply with the university's SAP policy will lead to a student losing their eligibility for federal financial assistance. **International students are not eligible for federal financial aid.**

Federal Financial Aid Application Process

All students applying for financial assistance must complete the Free Application for Federal Student Aid (FAFSA). This application is available at fafsa.ed.gov beginning October of the academic year prior to the academic year in which the student plans to attend. The Illinois Institute of Technology Title IV School Code is **001691**. The priority date for financial aid consideration at the university is February 7. All federal financial assistance is awarded on an annual basis; a FAFSA must be filed each academic year. The amount of financial aid a student receives each year depends on demonstrated financial need and the availability of funds. Students applying for federal financial aid may be required to submit tax information upon request.

Determining Financial Need for Assistance

Financial need is the difference between a student's total annual cost of attendance at the university and the amount the student is deemed able to contribute toward the cost of attendance. The total cost of attendance at the university includes tuition, mandatory fees, room and board, books and supplies, transportation, loan fees, and personal expenses. The amount that the student is deemed able to contribute is called the Expected Family Contribution (EFC).

The U.S. Department of Education has established the formula used to calculate the EFC based on the FAFSA information provided by a student and family. The EFC is subtracted from the cost of attendance and what is left over is considered to be the demonstrated need for financial assistance. One of the principles of need-based assistance is that students and their families are expected to help pay some of the cost of education.

Federal Financial Aid Programs

Federal Work Study Program

Federal Work Study (FWS) provides job funding for students with demonstrated financial need. Students awarded FWS can earn money to help pay educational expenses and are responsible for finding employment. Students can work either on or off-campus. Off-campus jobs will be with private, non-profit organizations or public agencies that provide community service work. Students awarded FWS are paid at least the current federal minimum wage or higher, depending on the type of work performed. Students are paid by the hour and receive a biweekly paycheck. FWS students cannot work more than 20 hours per week during the academic year and may not work during their scheduled class times. FWS positions are advertised through the Office of Career Service's (OCS) Jobs4Hawks database (web.iit.edu/career-services).

Federal Direct Loan Program

The Federal Direct Loan Program includes the Unsubsidized Stafford and PLUS Loan programs for graduate students. The interest rate for new loans is set on July 1 each year and is fixed. These loans must be repaid over a period of time after a student leaves school or drops below half-time enrollment.

Neither the Unsubsidized Stafford Loan nor the PLUS Loan are awarded based on demonstrated need and interest begins accruing from the time the loan funds are disbursed to the student. Students have the option of paying the interest while enrolled or having the interest added to the principal upon graduation or if attending less than half-time. Fees on each loan vary and are deducted before the funds are applied to a student's account. The PLUS Loan is a credit-based loan, hence some students may be ineligible for this loan program.

Federal Perkins Loan

The federal Perkins Loan is a low-interest federal loan for students with exceptional financial need who received a previous Perkins disbursement on or before June 30, 2015. This loan is made with governmental funds and serviced by the university. No interest is charged while the student is enrolled in school. When a student leaves school or drops below half-time, the loan enters a nine-month interest-free grace period before the student begins repayment. Once repayment begins, the loan accrues five percent of the principal each year. Perkins Loan funds are limited and awarded on a first-come, first-served basis. The final need criteria for this award are determined each year by the Office of Financial Aid.

As of early 2016, the Perkins Loan Program is operating because Congress passed the Perkins Loan Program Extension Act of 2015. This act extended the program through the 2017-2018 school year. If Congress does not reauthorize the Higher Education Act, or chooses not to draft another Perkins Extension Act, Illinois Institute of Technology will not be able to offer Perkins Loans for the 2018-2019 school year.

Additional Information

All **federal** financial aid awards for graduate students (excluding law and business students) are processed by the Office of Financial Aid. The office is open from 8:30 am to 5 pm, Monday through Friday, and may be found online at web.iit.edu/financial-aid/.

Applying for a Financial Assistantship

A fellowship provides financial support to defray the cost of tuition and a stipend for living expenses. A tuition scholarship (TS) covers all or part of a student's tuition charges. TS funding cannot be applied toward other charges. Most degree programs provide financial support for teaching assistants (TAs) who help with instruction, and research assistants (RAs) who work on funded research projects. Graduate assistants (GAs) receive partial support in the form of a stipend with no tuition support.

Only full-time students are eligible for assistantships. New students will be considered for fellowships, assistantships, and scholarships when they apply for admission and will be notified of the award with their admission decision or shortly thereafter. Continuing students should apply to their major academic unit. The Office of Graduate Admission administers a number of fellowships and scholarships but does not directly administer assistantships available to students in each academic unit. Acceptance of an award or appointment for the fall semester is considered binding on the student after April 15. If a student's academic work is judged to be unsatisfactory, the award may be canceled at the discretion of the university at anytime during the period covered.

Although an outstanding international student may receive some award from the university, most students must provide independent finances for their first year of graduate study. International students are required to carry at least nine credit hours per semester in order to maintain their F-1 student visa status.

Please note: the tuition scholarship and Federal Work Study plus any loan eligibility cannot exceed attendance cost for the academic year. Previously awarded loans may be adjusted after a tuition scholarship notification.

Alumni Tuition Voucher

Alumni who are registered in a graduate degree-seeking program (part-time or full-time status) and maintain good academic standing are permitted a reduction of one-third of the current tuition for one three-credit-hour course for each term of enrollment. Certain course exclusions, special program exclusions, and scholarship exclusions apply. Continuing eligibility is subject to the rules of master's and doctoral degree completion time limit (see Time Limit to Complete a Degree (p. 483)). The alumni benefit may not be applied retroactively.

Exclusions

- Alumni admitted in non-degree-seeking status or programs. This includes students in certificate programs.
- Alumni registered in only undergraduate courses or in Proficiency of English as a Second Language Courses (PESL).
- Alumni not registered in at least one three-credit-hour course.
- Alumni registered in a Chicago-Kent degree program.
- Alumni registered only in the following courses: accelerated, co-op, internship, non-credit, research, and thesis.
- The alumni tuition discount combined with all other university scholarships may not exceed tuition charges. Moreover, the alumni tuition discount will not be applied to students receiving the alumni half-tuition scholarship.
- Concurrently admitted and enrolled doctoral and master's degree candidates.

This discount is administered by the Office of Financial Aid and is awarded during the admissions process. Questions may be directed to finaid@iit.edu.

Alumni Half-Tuition

The Alumni Half-Tuition Scholarship is available to any degree-seeking student who graduated from Illinois Institute of Technology within the past two years with an undergraduate GPA of at least 3.5 out of 4.0. This award covers the cost of 4.5 credit hours (per semester) for full-time graduate students in their first year of study. The Alumni Half-Tuition Scholarship is only available to students enrolling in a graduate program in the College of Architecture, College of Science, School of Applied Technology, or Lewis College of Human Sciences. The Alumni Half-Tuition Scholarship does not apply to Illinois Institute of Technology alumni pursuing a second or additional graduate degree. After a student exhausts her/his half-tuition scholarship, s/he is eligible for the Alumni Tuition Discount.

Part-Time Employment

Part-time employment opportunities are available for students both on and off campus. External, off-campus positions and Experiential Learning (EL), which are career-related co-ops and internships, are managed by Career Services. Students interested in and eligible for employment off campus in their field of study can receive job search assistance from Career Services. Appointments for individual career coaching may be made online. Students are encouraged to be a part of the university's Experiential Learning Program, which ensures that the internship or co-op experience is vetted and officially recognized by the university.

The EL program is a requirement for international students pursuing internships or co-ops under immigration rules and regulations. More information about off-campus employment and Experiential Learning is available on the Career Services website at careerservices.iit.edu.

On-campus positions, including federal work study and non-federal work study jobs, are managed through the Student Employment Office. More information is available on the Student Employment Office website at iit.edu/seo.

International students (on F-1 visa) are restricted to on-campus employment for their first academic year of study at any school in the United States. After completing one academic year in the country, students on an F-1 visa may be eligible for opportunities off campus (only if related to their field of study) through the Experiential Learning Program.

Veterans' Educational Benefits

The Illinois Institute of Technology proudly participates in Montgomery GI Bill and Yellow Ribbon Program. Veterans who wish to process VA benefits at the university can find all relevant information at iit.edu/onestop/veterans. Veterans enrolling for the first time should contact the veteran representative in the Office of the One Stop by emailing onestop@iit.edu or calling 312.567.3810. The veteran must also inform the university Veterans Affairs representative in the Office of Financial Aid of any change in credit hours within a term or of future enrollment plans. If a veteran drops a course or withdraws from school completely, his or her allotment may be reduced or withdrawn. The veteran must report immediately the exact termination date to the Veterans Affairs representative. Veterans must maintain reasonable academic progress according to university standards. Failure to meet minimum-progress criteria can result in a cessation of educational benefits.

Taxation of Scholarships and Fellowships

U.S. Citizen or Resident Alien

A scholarship/fellowship payment received by a candidate for a degree is generally not taxable income to the student if it is used for qualified expenses. Qualified expenses are defined by the Internal Revenue Service (IRS) and include tuition and required fees, books, supplies, and equipment required of all students in the course. These payments do not need to be reported to the IRS by the student or Illinois Institute of Technology.

A scholarship/fellowship used for expenses other than qualified expenses is taxable income and includes payments that are used for living and incidental expenses such as room and board (housing), travel, research, clerical assistance, or equipment and other expenses that are not required for enrollment or attendance.

Although these payments are taxable income to the U.S. citizen or resident alien student, the IRS does not require the university to withhold tax on the payment. In addition, the university is not required to report these payments to the IRS. However, students are responsible for reporting these payments and remitting any tax due with their personal income tax returns.

Since the university cannot advise students regarding their personal tax matters, the student should consult with their personal tax adviser regarding the reporting of their scholarship/fellowship or stipend on their tax return.

International Student

The Internal Revenue Service (IRS) is the U.S. government agency that administers U.S. tax laws and collects taxes from individuals receiving payments in the United States. The U.S. tax system is based on a calendar year (January 1 through December 31).

The IRS requires that the university apply specific federal tax withholding and reporting rules to payments made to international students.

A scholarship/fellowship payment received by an international student who is a candidate for a degree is generally not taxable income to the student if it is used for qualified expenses. Qualified expenses are defined by the IRS and include tuition and required fees, books, supplies, and equipment required of all students in the course. These payments do not need to be reported to the IRS by the student or the university. A scholarship/fellowship used for expenses other than qualified expenses is taxable income and includes payments that are used for living and incidental expenses such as room and board (housing), travel, research, clerical assistance, or equipment and other expenses that are not required for enrollment or attendance. For these types of scholarships, international students with an F, J, M, or Q visa are subject to 14% federal tax withholding unless their country of residency has a tax treaty with the United States that excludes scholarships/fellowships from taxation. Payments made to international students in any other immigration status are subject to 30% withholding.

Since the university cannot advise students regarding their personal tax matters, the student should consult with their personal tax adviser regarding the reporting of their scholarship/fellowship on their tax return.

Student Accounting

Website: web.iit.edu/student-accounting

Financial Responsibility

Students take financial responsibility for the payment of all education related charges and fees that become a part of their student account when those charges are due regardless of their expected reliance on third-party resources such as financial aid, family gifts, employer reimbursement, private loans, outside scholarship or sponsorships. Any balance due to the university as the result of adjustments made to estimated or confirmed financial aid, the refusal to apply for any or all of the student's financial aid, or the inability to complete the financial aid verification become the student's responsibility for payment. Students agree to supply the Office of Financial Aid with any reasonable information or documents that they may request to complete the verification process in a timely manner. Students acknowledge that any outstanding balance due on their student account that is not timely paid when due is subject to service charges in the amounts or at the rates established and published by the university from time to time and that they will be prevented from registering for additional courses or obtaining official documents such as diplomas or transcripts until that outstanding balance has been paid in full. Failure to pay a past due debt may result in the debt being listed with the State Comptroller's Offset Program, referred to a collection agency, and/or other authorized legal debt collection procedures. Under such circumstances, the student is responsible for all fees and costs incurred by the university in the collection of the past due debt, including collection fees and/or attorney's fees.

Charges

All university mandatory and non-mandatory charges are published regularly. The official university publication of current tuition, fees, and other charges for all students can be found at web.iit.edu/student-accounting on the Tuition and Fees page. All other published tuition and fee information should be considered an estimate and not the official published rates. Continually rising costs do not permit the university to guarantee that published charges will not change. Students and parents should anticipate periodic increases in the future.

Admission Application Fee

All first time applications for graduate admission must be accompanied by a non-refundable fee. Any applicant who has attended Illinois Institute of Technology previously, or who has already paid an application fee to the university, does not have to pay a second application fee. Please contact the appropriate program admissions office for any applicable fee.

Enrollment Deposit

Each student admitted as a full-time degree-seeking graduate student to certain programs is required to make a non-refundable enrollment deposit, which is credited toward the student's cost of attendance and holds a place for the initial semester of enrollment.

Graduate Tuition

Graduate level enrollments are generally charged at a per credit hour tuition rate. This rate applies to all courses for which a graduate student registers, whether at the graduate or undergraduate level.

Some programs, particularly at Chicago-Kent College of Law and at Stuart School of Business, charge different rates depending on the program. Consult web.iit.edu/student-accounting for the official tuition rates.

No charge is assessed for seminars carrying zero credit hours. For review or other non-credit courses, tuition is computed by considering the number of class meetings per week as equivalent to the number of credit hours.

Graduate students registered for 9 credit hours or more are considered full-time. Graduate students registered for less than 9 credit hours are considered part-time.

Other Fees & Charges

A student may incur other fees and charges that are both mandatory and non-mandatory. For a complete current listing of all charges and fees, go to web.iit.edu/student-accounting and select Tuition and Fees. Books and supplies are available at the university bookstores. Costs for books and supplies can differ significantly depending upon the field of study. Students in the College of Architecture, for example, may spend less on books but substantially more on supplies.

Parking Fee

All students parking in campus parking lots must register their cars with Access, Card, and Parking Services and pay a parking fee at the beginning of the semester. For current fees, students should contact Access, Card, and Parking Services at iit.edu/acaps or 312.567.8968. Students authorized to park in university lots will receive a parking permit.

Student Health Insurance

All students who are registered for one billable hour are required to purchase the student health insurance policy or to submit proof of equivalent insurance before the end of the first week of classes. All students who are on an F-1 or J-1 visa and are registered for at least one class, participants in the co-op program, research or teaching assistants, or occupants of university residence halls are required to purchase the student health insurance. The premium for the insurance will be added to student tuition and fees as a charge. To avoid this charge, submit proof of comparable coverage online at iit.edu/shwc/insurance. F-1 and J-1 students may only waive the university's coverage with proof of employer provided insurance. Students must submit their waiver each fall. Other students, spouses, and dependents of students may participate in the student health program, if desired. Students should consult the Student Health and Wellness Center in IIT Tower, Suite 3D9-1, at 312.567.7550, for further details.

E-bills

Each semester, billing statements will be made available to students through the MyIIT portal (my.iit.edu) and such other responsible party or parties that a student designates as an authorized user(s) and for whom the student has provided the university with an email address. This statement will detail the then-current charges, payments, and other credits to the student's account, including the amount the student must pay and the date such payment is due. Notifications of new billing statements will be sent via email to the student's university email address as well as the email for any other responsible party that the student had designated. Students agree to monitor their university email account regularly.

Payment of Tuition, Room and Board, and Other Fees and Charges

Tuition and fees, less any authorized financial aid awards, are considered a student's out-of-pocket responsibility. The due date for all out-of-pocket payments will be posted each semester at iit.edu/student-accounting. All out-of-pocket payments must be paid by the due date. Payment plan information can be found at web.iit.edu/student-accounting. The deadline to enroll in a plan will be posted each semester at web.iit.edu/student-accounting.

Please see web.iit.edu/student-accounting/payments/payment-plans for options and instructions related to making payment.

Payment Policy

Illinois Institute of Technology establishes an account for each of its students for the purpose of charging tuition and fees, room and board, and other applicable university charges. Students can access their account information directly online by logging into the MyIIT portal (my.iit.edu) and looking under the Finances tab. Students can navigate to the "Manage My Student Account" channel and click on "Manage My Account." Students may view their charges, due dates for these charges, payments, and credits from financial aid at any time.

Payments of all charges for a term are due on the first day of the term to which the charges apply. If a student pays less than the total amount due by the respective due date, he/she will be assessed a monthly late payment fee of two percent on the remaining unpaid portion.

The Student Accounting Office will accept payment only up to the total amount of tuition and fees assessed to a student's account. Payments in excess of current charges will not be accepted.

The university does reserve the right to cancel registration depending on circumstances for non-payment. If a student has a past due balance remaining, in addition to the assessment of late payment fees, the student will have a hold placed on his or her records. This hold will prohibit a student from obtaining official transcripts and/or registering for future-term classes until the account balance is paid in full. To be able to register for the next term, students should pay their accounts in full. For more information about registration holds and late payments, please visit: web.iit.edu/student-accounting/payments/payment-policy/past-due-accounts.

Rejected Payments

If the university receives notification that a payment has been rejected for any reason, the returned amount will be charged to the student account along with a $50.00 fee. Payments rejected due to insufficient funds must be replaced with a cashier's check, money order, or credit card. Payments rejected due to invalid routing and/or account information or a closed account may be replaced with another electronic check from a different account. Following a second rejected payment, the university will no longer accept personal or electronic checks or electronic checks from the payee. All subsequent payments must be made by cashier's check, money order, or credit card.

Outstanding Debts/Late Fees/Financial Holds

Any outstanding balance due on a student's account that is not timely paid when due is subject to service charges in the amounts or at the rates established and published by the university from time to time. A restrictive hold is placed on a student's record when that student is delinquent in fulfilling his or her financial obligation to the university. A student will be considered delinquent when his or her account is not paid in full according to established university policies and by posted payment due dates. Students with outstanding university debt may be suspended from current term classes. Students will be prevented from registering for additional courses or obtaining official documents such as diplomas or transcripts until that outstanding balance has been paid in full. Students also acknowledge that failure to pay any amount due by the due date may result in an unfavorable report with credit bureaus and collection activities, including litigation.

Tuition Waiver Policy

Under exceptional circumstances such as withdrawal for involuntary military service, serious illness or injury, or action by the university, consideration may be given by the university for the issuing of a waiver for unused tuition upon written request to the academic department. Payments for charges other than tuition will remain the responsibility of the student. Students should consult iit.edu/registrar for the last day to add or drop a class without a penalty.

University Refund Policy

If a student's financial aid, including any disbursements of Title IV funds such as Pell grants or federal loans, creates a credit balance on their student account, they will be refunded any such overage. If any non-financial aid payments that are made results in an overpayment of the charges on a student's account, the university will hold these credits on the student account to be applied towards future charges, unless the student contacts the students contacts the Student Accounting Office to request a refund of the overpayment, or ceases to be enrolled.

Students must be enrolled in direct deposit to receive their student refund. Refunds from financial aid credits are processed throughout the semester. Student Accounting will send an email whenever the office processes a refund, provided the student is enrolled in direct deposit. There is no fee for receiving a refund via direct deposit. For a full explanation of the university's policies and procedures related to refunding student account credit balances, refer to web.iit.edu/student-accounting.

Title IV Federal Loan Authorizations

Health insurance fees, parking charges, and other items on a student bill **cannot** be automatically paid with Title IV Federal Loan funds. Students may authorize the university to pay these fees with Title IV Federal Loan funds by completing a Title IV Authorization form on the MyIIT portal and checking the "Pay Non-Institutional Charges" box. **Students who do not complete this Title IV Authorization may receive a refund and still owe the university money**.

Employer Tuition Deferment Plan

The Employer Tuition Deferment Plan allows students that are employed by a company that offers tuition reimbursement an opportunity to defer the reimbursable portion of their tuition until 45 days after grades are posted. By applying for the university's Tuition Employer Tuition Deferment Plan, students recognize that their employer's tuition reimbursement plan has qualifying conditions which they must meet in order to be reimbursed. Should a student's company refuse to pay this bill within the usual time frame for tuition deferment, the student will be personally responsible for this tuition and will be required to pay the bill in full. Students should also understand that a deferred payment fee of $55.00 will be due at the time of application, and it is non-refundable. If the tuition due under this agreement is not paid within three weeks following grades being posted, the student authorizes their employer to withhold the amount due from their pay and to pay that amount to Illinois Institute of Technology.

Students must understand that any amount not covered by the terms of their company's tuition reimbursement policy is due in full by the end of the add/drop registration period and is subject to fees and a hold preventing registration for the next term. If a student fails to meet the requirements to be eligible for the university's Employer Tuition Deferment Plan by the deadline, their tuition will not be deferred and will be due immediately.

Sponsor Billing (Third Party Invoicing)

Sponsor billing is the generation of an Illinois Institute of Technology (IIT) invoice to request payment of tuition/fees/housing for a student billed by the university to an external party or for the recovery of expenses incurred by the university on behalf of a student. Sponsors include outside parties, such as embassies, companies, and community agencies, who pay Illinois Institute of Technology directly for a student's educational expenses with funds that did not originate with the student.

Proof of Sponsorship Required

Students whose tuition and fees are paid by a sponsor need to submit proof of sponsorship from their sponsoring agency. Adequate documentation must:

- Be written in English on the sponsor's official stationery;
- Request the university to bill the sponsor for the student's charges;
- Identify the student by full name (given name first followed by family name) and Campus-Wide ID if available;
- Clearly state the type and percentage of charges the sponsor will pay;
- Include a billing address;
- Stipulate the exact begin and end dates of the period during which the sponsor will pay the student's charges (if the sponsor wishes to continue payment after the end date it must submit a new authorized letter);
- Contain no restrictions or contingencies (if, for example, the sponsor requires grades or transcripts prior to payment, the student must pay the original bill then seek reimbursement from the sponsoring organization);
- Be signed by an authorized official of the sponsoring organization.

Processing/Altering Sponsorship Agreement

Invoices will be processed after the add/drop registration date of each semester. Any changes in eligibility for a sponsored student should be communicated to the Student Accounting Office immediately.

Students that become ineligible or have a reduction in their sponsored amount will owe this amount immediately. A restrictive hold will be placed on the account to prevent registration for subsequent terms, as well as prevent students from obtaining any official paperwork from the university.

Late Sponsorship Payment

In the event a sponsor fails to remit payment for a student, the sponsorship coverage is removed. The student is responsible for all outstanding balances on the account after the sponsorship is removed. If the student believes payment was inadvertently delinquent, it is the responsibility of the student to communicate with the sponsor to rectify this situation.

Students that fail to submit required sponsorship documentation to the Student Accounting Office in a timely manner will be held responsible for any outstanding balance on the student account, as well penalty fees assessed to their accounts due to lack of payment.

Gainful Employment Information

As of July 1st, 2011, institutions must disclose the following information about each of the institution's certificate programs that lead to gainful employment: the name of the certificate program, the Classification of Instructional Programs Code (CIP) and the Standard Occupation Code (SOC), tuition and fee charges, the typical cost of books and supplies, and the average cost of room and board.

Illinois Institute of Technology's accreditor does not require the calculation of job placement rates and therefore the university is unable to disclose such rates. Once the National Center of Education Statistics (NCES) publishes its methodology for calculating placement rates, the university will use it to calculate such rates.

Per Gainful Employment guidelines, if the number of students who completed a Gainful Employment program during the award year was less than ten, the school cannot disclose median loan debt and on-time completion rate for privacy reasons.

This information is current and accurate as of the date of this publication. The most current information related to Gainful Employment Programs may be found on the Graduate Admission website at admissions.iit.edu/graduate.

Living Expenses

Housing

The university offers two types of housing:

- Residence halls for single undergraduates and graduate students
- Furnished apartments for upper-class, married, and single graduate students

All rooms come fully furnished with bed, desk, and desk chair. Apartments have fully furnished kitchens with appliances including oven, range, hood, and a refrigerator.

Applications must be submitted through the myroom.iit.edu website. Applications are processed in the order in which they are received. Room assignment timelines are available on the Residence and Greek Life website.

Students who arrive on campus without a housing confirmation may not be able to stay in the residence halls. There is no temporary housing on campus for students who do not sign a housing contract. For more information, please contact Residence and Greek Life at housing@iit.edu or visit the website at iit.edu/housing.

GRADUATE EDUCATION

Academic Programs

Graduate Degree Programs and General Requirements

The university's Armour College of Engineering, Chicago-Kent College of Law, College of Architecture, College of Science, Institute of Design, Lewis College of Human Sciences, School of Applied Technology, and Stuart School of Business award graduate degrees. In many fields, students in master's programs may choose either a thesis track or non-thesis track program. These academic units also work together to offer a wide variety of joint- and dual-degree programs.

Doctoral Degrees

Law Degrees

Master of Science Degrees

Professional Master's Degrees

These programs are specifically designed with the needs of professionals in mind. Most are course-only and do not require a thesis. In addition, the GRE requirement is waived for applicants to professional master's degree programs who hold a bachelor's degree from an accredited U.S. institution with a cumulative GPA of at least 3.0/4.0.

Co-Terminal Degree Programs

Co-terminal degrees allow outstanding Illinois Institute of Technology undergraduate students to simultaneously complete both an undergraduate and graduate degree (bachelor's degree and master's degree).

Co-terminal degrees provide an opportunity for students to gain greater knowledge in specialized areas while completing a smaller number of credit hours with increased scheduling flexibility than the completion of two degrees separately. Because most co-terminal degrees allow students to share course credit (a maximum of 9 credit hours), students may complete both a bachelor's and master's degree in as few as five years. All degree requirements must be completed within six years of undergraduate matriculation, or the student will be dismissed from the co-terminal degree program.

Co-terminal students maintain their undergraduate student status while completing graduate coursework, and can maintain financial aid eligibility when applicable.

The following are co-terminal degrees approved as of August 2016.

Applied Mathematics

- Bachelor of Science in Applied Mathematics/Master of Science in Applied Mathematics
- Bachelor of Science in Applied Mathematics/Master of Data Science
- Bachelor of Science in Computer Science/Master of Science in Applied Mathematics

Architecture

- Bachelor of Architecture/Master of Science in Architecture

Biology

- Bachelor of Science in Biochemistry/Master of Biology with Biochemistry specialization
- Bachelor of Science in Biochemistry/Master of Science in Biology with Biochemistry specialization
- Bachelor of Science in Biology/Master of Biology
- Bachelor of Science in Biology/Master of Science in Biology
- Bachelor of Science in Chemistry/Master of Science in Biology for the Health Professions

Business

- Bachelor of Science in Business Administration/Master of Public Administration
- Bachelor of Science in Business Administration/Master of Science in Finance
- Bachelor of Science in Business Administration/Master of Science in Marketing Analytics
- Bachelor of Science in Engineering Management/Master of Public Administration
- Bachelor of Science in Social and Economic Development Policy/Master of Public Administration

Chemical and Biological Engineering

- Bachelor of Science in Biomedical Engineering/Master of Chemical Engineering
- Bachelor of Science in Chemical Engineering/Master of Biological Engineering
- Bachelor of Science in Chemical Engineering/Master of Chemical Engineering
- Bachelor of Science in Chemistry/Master of Chemical Engineering

Chemistry

- Bachelor of Science in Chemistry/Master of Chemistry

Civil, Architectural, and Environmental Engineering

- Bachelor of Architecture/Master of Engineering in Construction Engineering and Management
- Bachelor of Science in Architectural Engineering/Master of Engineering in Architectural Engineering
- Bachelor of Science in Architectural Engineering/Master of Engineering in Construction Engineering and Management
- Bachelor of Science in Architectural Engineering/Master of Engineering in Structural Engineering
- Bachelor of Science in Chemical Engineering/Master of Engineering in Environmental Engineering
- Bachelor of Science in Civil Engineering/Master of Engineering in Construction Engineering and Management
- Bachelor of Science in Civil Engineering/Master of Engineering in Environmental Engineering
- Bachelor of Science in Civil Engineering/Master of Engineering in Geotechnical Engineering
- Bachelor of Science in Civil Engineering/Master of Engineering in Structural Engineering
- Bachelor of Science in Civil Engineering/Master of Engineering in Transportation Engineering

Computer Science

- Bachelor of Science in Applied Mathematics/Master of Computer Science
- Bachelor of Science in Applied Mathematics/Master of Science in Computer Science
- Bachelor of Science in Biology/Master of Computer Science
- Bachelor of Science in Biology/Master of Science in Computer Science
- Bachelor of Science in Computer Engineering/Master of Computer Science
- Bachelor of Science in Computer Engineering/Master of Science in Computer Science
- Bachelor of Science in Computer Science/Master of Computer Science
- Bachelor of Science in Computer Science/Master of Science in Computer Science
- Bachelor of Science in Computer Science/Master of Data Science
- Bachelor of Science in Physics/Master of Computer Science
- Bachelor of Science in Physics/Master of Science in Computer Science

Electrical and Computer Engineering

- Bachelor of Science in Biomedical Engineering/Master of Biomedical Imaging and Signals
- Bachelor of Science in Computer Engineering/Master of Electrical and Computer Engineering
- Bachelor of Science in Computer Engineering/Master of Science in Computer Engineering
- Bachelor of Science in Computer Engineering/Master of Science in Electrical Engineering
- Bachelor of Science in Electrical Engineering/Master of Electrical and Computer Engineering
- Bachelor of Science in Electrical Engineering/Master of Science in Computer Engineering
- Bachelor of Science in Electrical Engineering/Master of Science in Electrical Engineering

Food Science and Nutrition

- Bachelor of Science in Biochemistry/Master of Food Safety and Technology
- Bachelor of Science in Biology/Master of Food Safety and Technology
- Bachelor of Science in Chemical Engineering/Master of Food Process Engineering
- Bachelor of Science in Chemistry/Master of Food Safety and Technology

Industrial Technology and Management

- Bachelor of Industrial Technology and Management/Master of Industrial Technology and Operations

Information Technology and Management

- Bachelor of Information Technology and Management/Master of Cyber Forensics and Security
- Bachelor of Information Technology and Management/Master of Information Technology and Management

Intellectual Property Management and Markets

- Bachelor of Science in Computer Science/Master of Intellectual Property Management and Markets

Mechanical, Materials, and Aerospace Engineering

- Bachelor of Science in Aerospace Engineering/Master of Engineering in Materials Science and Engineering
- Bachelor of Science in Aerospace Engineering/Master of Engineering in Mechanical and Aerospace Engineering
- Bachelor of Science in Mechanical Engineering/Master of Engineering in Materials Science and Engineering
- Bachelor of Science in Mechanical Engineering/Master of Engineering in Mechanical and Aerospace Engineering

Physics

- Bachelor of Science in Physics/Master of Health Physics
- Bachelor of Science in Physics/Master of Science in Physics

Graduate Certificate Programs

Designed to provide knowledge in a specialized area within an academic discipline, these programs typically consist of 9-12 credit hours of coursework that might otherwise be applicable to a master's degree. Students who successfully complete graduate certificate programs and who subsequently apply for admission and are admitted to a master's degree program at the university may apply all approved coursework taken in the certificate program and passed with a grade of "B" or better toward the master's degree. Admission to a certificate program does not guarantee future admission to a degree program.

With a few exceptions, Illinois Institute of Technology's graduate certificate programs are eligible for the Gainful Employment Programs. For a complete list of eligible certificates, see iit.edu/grad_adm/.

Chemical and Biological Engineering

- Biological Engineering (p. 61)
- Current Energy Issues (p. 61)
- Particle Processing (p. 61)
- Pharmaceutical Engineering (p. 62)
- Polymer Science and Engineering (p. 62)
- Process Operations Management (p. 62)

Chemistry

- Analytical Method Development (p. 252)
- Analytical Spectroscopy (p. 252)
- Characterization of Inorganic and Organic Materials (p. 253)
- Chromatography (p. 253)
- Regulatory Science (p. 254)
- Synthesis and Characterization of Inorganic Materials (p. 253)
- Synthesis and Characterization of Organic Materials (p. 253)

Civil, Architectural, and Environmental Engineering

- Air Resources (p. 91)
- Architectural Engineering (p. 91)
- Construction Management (p. 91)
- Earthquake and Wind Engineering Design (p. 92)
- Hazardous Waste Management (p. 92)
- Indoor Air Quality (p. 92)
- Infrastructure Engineering and Management (p. 93)
- Transportation Systems Planning (p. 94)
- Water and Wastewater Treatment (p. 94)

Computer Science

- Computational Intelligence (p. 286)
- Cyber-Physical Systems (p. 286)
- Data Analytics (p. 286)
- Database Systems (p. 287)
- Distributed and Cloud Computing (p. 287)
- Information Security and Assurance (p. 288)
- Networking and Telecommunications (p. 288)
- Software Engineering (p. 288)

Electrical and Computer Engineering

- Advanced Electronics (p. 137)
- Applied Electromagnetics (p. 137)
- Communication Systems (p. 138)
- Computer Engineering (p. 138)
- Control Systems (p. 139)
- Electricity Markets (p. 139)
- Power Electronics (p. 140)
- Power Engineering (p. 140)
- Signal Processing (p. 141)
- Wireless Communications Engineering (p. 142)

Environmental Management

- Compliance and Pollution Prevention
- Sustainable Enterprise

Food Science and Nutrition

- Food Process Engineering (p. 374)
- Food Processing Specialist (p. 374)
- Food Safety and Industrial Management (p. 375)
- Food Safety and Technology (p. 375)

Humanities

- Instructional Design (p. 341)
- Technical Communication (p. 341)

Information Technology and Management

- Advanced Software Development (p. 403)
- Cyber Security Management (p. 403)
- Cyber Security Technologies (p. 404)
- Data Center Operations and Management (p. 404)
- Data Management and Analytics (p. 405)
- Digital Voice and Data Communication Technologies (p. 405)
- Information Technology Innovation, Leadership, and Entrepreneurship (p. 406)
- System Administration (p. 406)
- Systems Analysis (p. 407)
- Web Design and Application Development (p. 407)

Mechanical, Materials, and Aerospace Engineering

- Computer Integrated Design and Manufacturing (p. 175)

Physics

- Radiological Physics (p. 313)

Psychology

- Psychiatric Rehabilitation (p. 360)
- Rehabilitation Counseling (p. 360)
- Rehabilitation Engineering Technology (p. 360)

Professional Certificates

Stuart School of Business

Business Administration

- Business Analyst
- Compliance and Pollution Prevention
- Corporate Finance (p. 452)
- Entrepreneurial Finance (p. 452)
- Financial Economics (p. 453)
- Financial Modeling (p. 453)
- Financial Toolbox (p. 453)
- Fundamentals of Finance (p. 453)
- Innovation and Emerging Enterprises
- Investments (p. 453)
- Marketing Management
- Risk Management (p. 455)
- Sustainable Enterprise
- Trading (p. 455)

Public Administration

- Economic Development and Social Entrepreneurship (p. 452)
- Nonprofit and Mission-Driven Management (p. 454)
- Public Management (p. 454)
- Security, Safety, and Risk Management (p. 455)

Undergraduate Programs

A complete description of undergraduate programs and admission requirements is available from the Office of Undergraduate Admission at admissions.iit.edu/undergraduate/.

Credit Requirements

The Master's and Master of Engineering degrees are fulfilled with a minimum of 30 credit hours earned beyond the bachelor's degree at Illinois Institute of Technology. The Master of Science degree is fulfilled with a minimum of 32 credit hours earned beyond the bachelor's degree. With academic approval, a maximum of nine credit hours, earned with the grade of "A" or "B", may be transferred from an accredited institution or foreign institution meeting Illinois Institute of Technology requirements.

The doctoral degree is fulfilled with a minimum of 72 credit hours (or more) earned beyond the bachelor's degree, of which at least 36 credit hours of academic coursework is required. Consult the Graduate Bulletin for the minimum doctoral degree credit requirements by program. Research requirements are fulfilled with a minimum of 24 research (691) credit hours earned, and a maximum of 50% or 48 research (691) credit hours, whichever is lower, of the doctoral program credit requirement. The equivalent of at least one year of full-time work devoted to research is required. In general, this requirement is fulfilled when the oral defense is passed. With academic approval, a master's degree, up to 32 credit hours, may be transferred from an accredited institution or foreign institution meeting Illinois Institute of Technology requirements.

Synopsis of Graduate Studies

The following guideline for prospective and current students shows the steps that must be taken and the forms that must be completed, signed by appropriate university officials, and submitted to the Office of Graduate Academic Affairs in order to proceed from application to graduation to receipt of degree. The forms indicate which signatures are needed. All forms are available at web.iit.edu/gaa/students/student-forms.

M.S. Students

For applicants	Form or Application Required
1. Formal Application	Regular application and all supporting materials including official transcripts, letters of recommendation, test scores (if required), professional statement, portfolio (if required) and application fee.
2. Admission decision	Admission email from the Office of Graduate Admission outlining terms of admission offer, or informing the student that admission has been denied.
For admitted and continuing M.S. students	
3. Registration	Registration may be completed online at the MyIIT portal (https://my.iit.edu) under the Academics tab. Continuing students who are not enrolling for the current term must file a request for leave or university withdrawal (see the section on Leave of Absence).
4. Approval of the Degree Works Plan of Study	The Plan of Study must be submitted by the master's student online, within 9 credit hours of earned and/or enrolled coursework using Graduate Degree Works, which is located in the MyIIT portal (https://my.iit.edu) under the Academics tab. The form and changes to it require adviser, academic unit, and Graduate Academic Affairs approval.
5. Preliminary M.S. thesis approval	Form G501A (if required).
6. Final thesis/comprehensive examination for M.S. or MAS where applicable	Department submits Form G303. (if required).[1]
7. Final M.S. thesis committee appointed	Form G301B (if required).
8. Thesis fee (if applicable)	Student Accounting Touchnet Paid Online receipt.
9. M.S. thesis approval signed by the thesis examiner	Form G501B.
10. Completion of courses and other requirements	Listed on the Plan of Study and the Graduate Degree Works Worksheet Final Audit, including approved exceptions.
11. Fulfillment of all financial obligations to the university	
12. Application for graduation (including application fee(s))	Filed using Banner Student Self Service by the deadline shown in the university calendar. Late graduation applications may be filed no later than 30 days prior to the last day of the semester, and require Form G527L and a late graduation application fee.
13. Commencement (attendance is voluntary)	The Office of Marketing and Communications announces details in spring semester (one ceremony per year). RSVP is required by the deadline shown at http://web.iit.edu/commencement/students.
14. Diploma	Registrar will mail diplomas after semester grades are reported, except spring semester when diplomas are distributed at the commencement ceremony to participants who have met all degree requirements. Details are located at http://web.iit.edu/registrar/students.

1 Form G303 (exam result form) is not given to students. Academic units send G303 forms to the Office of Graduate Academic Affairs.

Ph.D. Students

For applicants	Form or Application Required
1. Formal Application	Regular application and all supporting materials including official transcripts, letters of recommendation, test scores (if required), professional statement, portfolio (if required) and application fee.
2. Admission decision	Admission email from the Office of Graduate Admission outlining terms of admission offer, or informing the student that admission has been denied.
For admitted and continuing Ph.D. students	
3. Registration	Registration may be completed online at the MyIIT portal (https://my.iit.edu) under the Academics tab. Continuing students who are not enrolling for the current term must submit a request for leave or university withdrawal (see the section on Leave of Absence).
4. Approval of the Degree Works Plan of Study	The Plan of Study must be submitted by the doctoral student online, after 18 credit hours of earned and/or enrolled coursework using Graduate Degree Works, which is located in the MyIIT portal (https://my.iit.edu) under the Academics tab. The form and revisions to it require adviser, academic unit, and Graduate Academic Affairs approval.
5. Ph.D. qualifying examination	Department administering exam submits Form G303.[1]
6. Ph.D. comprehensive examination	Form G301A. Department submits exam results on Form G309.[1]
7. Fulfillment of Ph.D. residency requirement	No form needed.
8. Appointment of the thesis examining committee/comprehensive examination committee	Form G301A.
9. Preliminary Ph.D. thesis approval	Form G501A.
10.Final Ph.D. thesis committee appointed	Form G301B.
11. Final thesis defense/oral examination	Department submits exam results on Form G309.[1]
12.Thesis fee	Student Accounting Touchnet Paid Online receipt.
13. Ph.D. thesis approval signed by the thesis examiner	Form G501B.
14. Completion of courses and other requirements	Listed on the Plan of Study and the Graduate Degree Works Worksheet Final Audit, including approved exceptions.
15. Fulfillment of all financial obligations to the university	
16. Application for graduation (including application fee(s))	Filed using Banner Student Self Service by the deadline shown in the university calendar. Late graduation applications may be filed no later than 30 days prior to the last day of the semester, and require Form G527L and a late graduation application fee.
17. Commencement (attendance is voluntary)	The Office of Marketing and Communications announces details in spring semester (one ceremony per year). RSVP is required by the deadline shown at http://web.iit.edu/commencement/students.
18. Diploma	Registrar will mail diplomas after semester grades are reported, except spring semester when diplomas are distributed at the commencement ceremony to participants who have met all degree requirements. Details are located at http://web.iit.edu/registrar/students.

Note: copies of the forms, applications, and the sequence of events may be obtained from the website web.iit.edu/gaa.

1 Forms G303 and G309 (exam results forms) are not given to students. Academic units send G303 and G309 forms to the Office of Graduate Academic Affairs.

Synopsis of Co-Terminal Studies

Co-terminal degrees allow outstanding Illinois Institute of Technology undergraduate students to simultaneously complete both an undergraduate and graduate degree (bachelor's degree and master's degree).

Co-terminal degrees provide an opportunity for students to gain greater knowledge in specialized areas while completing a smaller number of credit hours with increased scheduling flexibility than the completion of two degrees separately. Because most co-terminal degrees allow students to share course credit (a maximum of 9 credit hours), students may complete both a bachelor's and master's degree in as few as five years. All degree requirements must be completed within six years of undergraduate matriculation, or the student will be dismissed from the co-terminal degree program. A student who is placed on undergraduate academic probation may be dismissed from the co-terminal program pending review.

Admission

Students applying to co-terminal studies must have completed at least 60 credit hours of applicable undergraduate study and at least one full-semester (12 credit hours) at the university. Students must be at least one full-time semester (12 credit hours) away from undergraduate degree completion in order to apply. Applicants are required to have a minimum GPA of 3.0/4.0; however, please consult individual departments for specific minimum GPA requirements. The deadlines for application to co-terminal admission are:

- June 15th for fall semester
- November 15th for spring semester
- April 15th for summer semester (all sessions)

Questions regarding co-terminal admission should be addressed to the Co-Terminal and Dual Degree Manager in the Office of Graduate Academic Affairs at cotermdegrees@iit.edu.

Plan of Study

Before completion of 9 credit hours of graduate coursework applicable to the co-terminal degree program, and in the first semester of co-terminal enrollment, a Plan of Study must be filed with and approved by the co-terminal academic adviser, the academic unit head, and the Office of Graduate Academic Affairs. The Plan of Study is created and filed in Graduate Degree Works, which is accessed in the MyIIT portal (my.iit.edu) under the Academics tab in the Graduate Academic Affairs channel. The Plan of Study is used to monitor the successful completion of the master's degree requirements.

Academic Standing

Co-terminal students must maintain satisfactory grade point averages and a satisfactory rate of progress towards the completion of their co-terminal degrees. The university considers co-terminal students to have an undergraduate student status throughout the course of their studies; however, students are subject to both undergraduate and graduate academic policies.

Co-terminal students who do not earn at least a 2.0 cumulative GPA, a 1.85 term GPA, a 2.0 major GPA, or who do not maintain satisfactory academic progress are placed on undergraduate academic probation. Co-terminal students who are placed on undergraduate academic probation will be dismissed from the co-terminal program.

Graduate academic standing review will be initiated when a co-terminal student completes 9 credit hours of graduate or shared coursework. In order to remain in good academic standing on the graduate level, co-terminal students must maintain a GPA of 3.0/4.0. A student who earns a GPA of less than 3.0/4.0 will be placed on graduate academic probation. If in subsequent semesters the co-terminal student fails to make the requisite academic progress in accordance with graduate academic standing rules, he or she will be dismissed from co-terminal study.

Dismissal

A student dismissed from co-terminal degree status may still complete the undergraduate degree following the academic rules of undergraduate study. A student who is dismissed from co-terminal degree status may apply for non-coterminous graduate degree admission in the future, but shared credit earned will not be applied to the graduate degree.

Armour College of Engineering

Natacha DePaola
Dean
Perlstein Hall, Suite 224
10 W. 33rd St.
Chicago, IL 60616
312.567.3009
engineering.iit.edu

Armour College of Engineering traces its roots to Armour Institute, founded in 1892 to prepare students of all backgrounds for leadership roles—primarily as engineers—in a challenging industrial society. Armour College carries on that tradition of excellence in engineering education and research.

Today, Armour College is home to about 100 full-time faculty, more than 2,500 undergraduate and graduate students, and the graduate and undergraduate programs of five engineering departments.

Undergraduate degrees offered by Armour College are accredited by the Engineering Accreditation Commission of the Accreditation Board of Engineering and Technology. All Illinois Institute of Technology graduate and undergraduate programs are also accredited by the North Central Association (NCA).

The mission of Armour College of Engineering is to: provide state-of-the-art education and research programs that enhance Armour's reputation as an internationally recognized engineering school; educate a new breed of engineers with a strong fundamental knowledge of engineering principles and an understanding and appreciation of the economic, environmental, and social forces that impact intellectual choices; and strengthen Armour's leadership role by focusing on the core research competencies and enhancing partnerships with industry, government laboratories, and academic and research institutions.

Biomedical Engineering

Chemical and Biological Engineering

Dual Degree Program

Interdisciplinary Programs

Certificate Programs

Civil, Architectural, and Environmental Engineering

Interdisciplinary Programs

Certificate Program in Architectural Engineering

Certificate Programs in Civil Engineering

Certificate Programs in Environmental Engineering

Electrical and Computer Engineering

Dual Degree Program

Joint Degree Programs

Interdisciplinary Programs

Certificate Programs

Mechanical, Materials, and Aerospace Engineering

Interdisciplinary Programs

Certificate Program

Biomedical Engineering

Wishnick Hall 314
3255 S. Dearborn St.
Chicago, IL 60616
312.567.5324
312.567.5770 (fax)
bme@iit.edu
engineering.iit.edu/bme

Chair
John G. Georgiadis

Faculty with Research Interests
For more information regarding faculty visit the Department of Biomedical Engineering website.

The Department of Biomedical Engineering confers a doctoral degree in biomedical engineering (Ph.D. in Biomedical Engineering). Currently, eight faculty members hold tenured positions, and one faculty member holds a tenure track position in the department. Several departments at the university contribute courses and faculty to the graduate program:

- Biology
- Chemistry
- Physics
- Chemical and Biological Engineering
- Computer Science
- Electrical and Computer Engineering
- Mechanical, Materials, and Aerospace Engineering
- Psychology
- Center for Ethics in the Professions

An M.D./Ph.D. program is in place whereby students with engineering backgrounds can receive a Ph.D. in Biomedical Engineering at Illinois Institute of Technology and an M.D. from the University of Chicago. Qualified students are admitted to the MSTP (Medical Scientist Training Program) at the University of Chicago and subsequently apply to the Department of Biomedical Engineering for their Ph.D. studies.

Research Areas

- Cell and tissue engineering
- Medical imaging
- Neural engineering

Admission Requirements

Minimum cumulative undergraduate GPA: 3.2/4.0

GRE minimum scores:

1800 (combined)
1200 (quantitative + verbal)
3.0 (analytical writing)

Meeting the minimum admission standards for GPA and GRE scores does not guarantee admission. Test scores and GPA are just two of several important factors considered. The admissions committee will also consider recommendations from three college faculty members acquainted with the character, research ability, potential, qualifications, and motivation of the applicant, and the needs of the departmental faculty. Entering graduate students are assigned a temporary academic adviser who will provide initial guidance. As their research and other academic interests become defined, students select a permanent research adviser, who will also guide them through their academic studies.

Degrees Offered

- Master of Biomedical Engineering (p. 43)
- Master of Science in Biomedical Engineering (p. 43)
- Doctor of Philosophy in Biomedical Engineering (p. 43)

Course Descriptions

BME 500
Introduction to Biomedical Engineering
Introduction to the concepts and research in biomedical engineering. Provides an overview of current biomedical engineering research areas, emphasis on application of an engineering approach to medicine and physiology signals.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 501
Communication Skills in Biomedical Engineering
Students will be taught to critically analyze manuscripts in the biomedical engineering literature. They will write a critique of the manuscripts, discuss the manuscripts in class, and prepare power point presentations that will be presented and evaluated by the entire class.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 503
Mathematical and Statistical Methods for Neuroscience I
This quarter introduces mathematical ideas and techniques in a neuroscience context. Topics will include some coverage of matrices and complex variables; eigen value problems, spectral methods and Greens functions for differential equations; and some discussion of both deterministic and probabilistic modeling in the neurosciences. Instructor permission required.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 504
Neurobiology
This course is concerned with the structure and function of systems of neurons, and how these are related to behavior. Common patterns of organization are described from the anatomical, physiological, and behavioral perspectives of analysis. The comparative approach is emphasized throughout. Laboratories include exposure to instrumentation and electronics, and involve work with live animals. A central goal of the laboratory is to expose students to in vivo extracellular electrophysiology in vertebrate preparations. Laboratories will be attended only on one day a week but may run well beyond the canonical period. Instructor permission required.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 505
Mathematical and Statistical Methods for Neuroscience II
This quarter treats statistical methods important in understanding nervous system function. It includes basic concepts of mathematical probability; information theory, discrete Markov processes, and time series. Instructor permission required.
Prerequisite(s): [(BME 503)]
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 506
Computational Neuroscience II: Vision
This course considers computational approaches to vision. It discusses the basic anatomy and physiology of the retina and central visual pathways, and then examines computational approaches to vision based on linear and non-linear systems theory, and algorithms derived from computer vision.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 507
Cognitive Neuroscience
This course is concerned with the relationship of the nervous system to higher order behaviors such as perception and encoding, action, attention and learning and memory. Modern methods of imaging neural activity are introduced, and information theoretic methods for studying neural coding in individual neurons and populations of neurons are discussed. Instructor permission required.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 508
Mathematics and Statistics for Neuroscience III
This course covers more advanced topics including perturbation and bifurcation methods for the study of dynamical systems, symmetry methods, and some group theory. A variety of applications to neuroscience with be described. Instructor permission required.
Prerequisite(s): [(BME 503 and BME 505)]
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 509
Vertebrate Neural Systems
This lab-centered course teaches students the fundamental principles of mammation neuroanatomy. Students learn the major structures and the basic circuitry of the CNS and PNS. Students become practiced at recognizing the nuclear organization and cellular architecture of many regions in animal brain models. This course is taught at the University of Chicago. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 510
Neurobiology of Disease I
This seminar course is devoted to basic clinical and pathological features and pathogenic mechanisms of neurological diseases. The first semester is devoted to a broad set of disorders ranging from developmental to acquired disorders of the central and peripheral nervous system. Weekly seminars are given by experts in the clinical and scientific aspects of the disease under discussion. For each lecture, students are given a brief description of clinical and pathological features of a given set of neurological diseases followed by a more detailed description of the current status of knowledge of several of the prototypic pathogenic mechanisms.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 511
Extracellular Matrices: Chemistry and Biology
Advanced topics dealing with the biology and chemistry of the extracellular matrix, cell-matrix interactions, and current methodologies for engineering these interfaces.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 512
Behavioral Neurosciences
This course is concerned with the structure and function of systems of neurons and how these are related to behavior. Common patterns of organization are described from the anatomical, physiological, and behavioral perspectives of analysis. The comparative approach is emphasized throughout. Laboratories include exposure to instrumentation and electronics and work involvement with live animals.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 513
Methods of Computational Neuroscience: Single Neurons
Topics include, but are not limited to, Hodgkin-Huxley equations, cable theory, single neuron models, information theory, signal detection theory, reverse correlation, relating neural responses to behavior, and rate versus temporal codes. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 516
Biotechnology for Engineers
This course will provide students opportunity to learn about the field of biotechnology and how to apply engineering principles to biological systems and living organisms for betterment of medicines as well as agricultural products. The course covers the introduction to biotechnology with information about cell and molecular biology, the role of enzyme and growth kinetics, media preparations for cell culture and various chromatographic techniques, and antibiotics and its role in secondary metabolic production. Biological effluent treatment and regulatory issues to obtain FDA will be taught. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 517
Technologies for Treatment of Diabetes
Study of physiological control systems and engineering of external control of biological systems by focusing on an endocrine system disorder -- diabetes. The effects of type 1 diabetes on glucose homeostasis and various treatment technologies for regulation of glucose concentration. Development of mathematical models describing the dynamics of glucose and insulin concentration variations, blood glucose concentration measurement and inference techniques, insulin pumps, and artificial pancreas systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 518
Reaction Kinetics for Biomedical Engineering
This course is an introduction to the fundamentals of chemical kinetics. Analysis of rate data; single and multiple reaction schemes. Biomedical topics include biological systems, enzymatic pathways, enzyme and receptor-ligand kinetics, pharmacokinetics, heterogeneous reactions, microbial cell growth and product formation, and the design and analysis of biological reactors.
Corequisite(s): BME 482
Prerequisite(s): [(BME 301, BME 335, and MATH 252)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 519
Cardiovascular Fluid Mechanics
Anatomy of the cardiovascular system. Scaling principles. Lumped parameter, one-dimensional linear and nonlinear wave propagation, and three-dimensional modeling techniques applied to simulate blood flow in the cardiovascular system. Steady and pulsatile flow in rigid and elastic tubes. Form and function of blood, blood vessels, and the heart from an engineering perspective. Sensing, feedback, and control of the circulation. Includes a student project.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 521
Medical Imaging
Study of modern technology for medical imaging. Theory and operation of CAT, SPECT, PET, MRI, X-ray and echo imaging modalities.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 522
Mathematical Methods in Biomedical Engineering
Graduate standing in BME or consent of instructor This course is an introductory graduate level course that integrates mathematical and computational tools that address directly the needs of biomedical engineers. The topics covered include the mathematics of diffusion, pharmacokinetic models, biological fluid mechanics, and biosignal representations and analysis. The use of MATLAB will be emphasized for numerically solving problems of practical relevance.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 523
Cell Biomechanics: Principles and Biological Processes
This course will provide students an opportunity to learn about mechanical forces that develop in the human body and how they can influence cell functions in a range of biological processes from embryogenesis, wound healing, and regenerative medicine to pathological conditions such as cancer invasion. Examples of research methods for investigating cell biomechanics in various biological systems will be discussed. Permission of instructor is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 524
Quantitative Aspects of Cell andTissue Engineering
This course is designed to cover fundamentals of cell and tissue engineering from a quantitative perspective. Topics addressed include elements of tissue development, cell growth and differentiation, cell adhesion, migration, molecular and cellular transport in tissues and polymeric hydrogels for tissue engineering and drug delivery applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 525
Microfluidics for Biomedical Engineering
This course will present fundamentals and applications of microfluidic technologies for applications in the broad biomedical engineering. It will provide a broad view of the field of microfluidics and a knowledge of relevant fabrication methods and analysis techniques. Microfluidic fabrication techniques, interfacing with biological materials, and techniques for analyte detection in microchannels will be emphasized. The course will include individual projects and critical paper reviews in which each student is expected to demonstrate a grasp of basic concepts in microfluidic design and fabrication for specific applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 530
Inverse Problems in Biomedical Imaging
This course will introduce graduate students to the mathematical theory of inverse problems. Concept from functional analysis will be applied for understanding and characterizing mathematical properties of inverse problems. This will permit for the analysis of the stability and resolution of image reconstruction algorithms for various existing and novel biomedical imaging systems. The singular value decomposition (SVD) is introduced and applied for understanding fundamental properties of imaging systems and reconstruction algorithms. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 532
Medical Imaging Science
This course is an introduction to basic concepts in medical imaging, such as: receiver operating characteristics, the rose model, point spread function and transfer function, covariance and auto covariance, noise, filters, sampling, aliasing, interpolation, and image registration. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 533
Biostatistics
This course is designed to cover the tools and techniques of modern statistics with specific applications to biomedical and clinical research. Both parametric and nonparametric analysis will be presented. Descriptive statistics will be discussed although emphasis is on inferential statistics and experimental design.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 535
Magnetic Resonance Imaging
This is an introduction to the Physics and technology of magnetic resonance imaging (MRI). the topics that are covered include: basic MR physics, source of signal, signal acquisition, pulse sequences, hardware, artifacts, spectroscopy, and advanced imaging techniques. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 537
Introduction to Molecular Imaging
This course provides an overview of molecular imaging, a subcategory of medical imaging that focuses on noninvasively imaging molecular pathways in living organisms. Topics include imaging systems, contrast agents, reporter genes and proteins, tracer kinetic modeling. Preclinical and clinical applications will also be discussed with an emphasis on cancer and the central nervous system.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 538
Neuroimaging
This course describes the use of different imaging modalities to study brain function and connectivity. The first part of the course deals with brain function. It includes an introduction to energy metabolism in the brain, cerebral blood flow, and brain activation. It continues with an introduction to magnetic resonance imaging (MRI), perfusion-based fMRI, Bold fMRI, fMRI paradigm design and statistical analysis, introduction to positron emission tomography, (PET) and studying brain function with PET, introduction to magneto encephalography (MEG) and studying brain function with MEG. The second part of the deals with brain connectivity. It includes an introduction to diffusion tensor MRI, explanation of the relationship between the diffusion properties of tissue its structural characteristics, and white matter fiber tractography techniques. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 539
Advanced Medical Imaging
This course introduces advanced clinical imaging modalities, research imaging techniques, and concepts from image science and image perception. The first part of the course introduces the perception of image data by human observers and the visualization of brain structure and function. It includes an introduction to magnetic resonance imaging (MRI) and a survey of neurological imaging via functional MRI (fMRI). The second part of the course covers image science, clinical imaging applications, and novel research imaging techniques. It includes an introduction to radiation detection and image quality evaluation, a survey of clinical cases, and an overview of new imaging methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 540
Wave Physics and Applied Optics for Imaging Scientists
This course will introduce students to fundamental concepts in wave physics and the analysis of optical wave fields. These principles will be utilized for understanding existing and novel imaging methods that employ coherent radiation. Solutions to inverse scattering and inverse source problems will be derived and algorithmic realizations of the solutions will be developed. Phase contrast imaging techniques and X-ray imaging systems that employ coherent radiation will be studied. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 542
Advanced Concepts in Image Science
This graduate level course introduces students to fundamental concepts in image science that are related to the optimization and evaluation of biomedical imaging systems. Topics covered include: deterministic descriptions of imaging systems, stochastic descriptions of imaging systems, statistical decision theory, and objective assessment of image quality.
Prerequisite(s): [(BME 530 and BME 532)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 543
Bioinstrumentation and Electronics
Principles of circuit analysis are applied to typical transducer and signal recording situations found in biomedical engineering. Basic electrical and electronic circuit theory is reviewed with an emphasis on biomedical measurement applications. a special topic is individually studied by the student and presented to the class electrical physics class or basic circuits.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 551
Physiological Signal Processing and Control Theory
This is the first of a 2 part course co-taught at IIT and the University of Chicago. essential elements of signal processing and control theory as it is applied to physiological systems will be covered. Part I will cover data acquisition and sampling, Laplace and Fourier transforms, filtering, time and frequency domains, system descriptions and lumped vs. distributed parameters. Students will use Mat lab to test concepts presented in class.
Lecture: 2 **Lab:** 0 **Credits:** 2

BME 552
Control Systems for Biomedical Engineers
Control systems design and analysis in biomedical engineering. Time and frequency domain analysis, impulse vs. step response, open vs. closed loop response, stability, adaptive control, system modeling. Emphasis is on understanding physiological control systems and the engineering of external control of biological systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 553
Quantitative Physiology
The primary objective of this course is to introduce students to basic physiological concepts using a quantitative approach. The main systems that control the human body functions will be reviewed to enable the students to understand the individual role of each major functional system as well as the need for the integration or coordination of the activities of the various systems. Attempts will be made to highlight the patho-physiological consequences of defects or failures in the organ systems and the relevant corrective approaches. This course will include lectures from individuals who have relevant expertise in the different organ systems because of the complexity of the human body.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 575
Neuromechanics of Human Movement
This course will explore how we control movement of our extremities, with concepts drawn from mechanics and neurophysiology. The progression from neurological signals to muscle activation and resulting movement of the hand or foot will be modeled, starting at the periphery and moving back toward the central nervous system. Biomechanics of the limbs will be modeled using dynamic simulation software (Working Model) which will be driven by a neural controller, implemented in MATLAB. Issues related to sensory feedback and redundancy will be addresses.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 581
Fluid Mechanics for Biomedical Engineers
This course is primarily focused on the development of theoretical and experimental principles necessary for the delineation of fluid flow in various in vitro chambers and the cardiovascular system. Its content will primarily deal with the basic concepts of flow in various geometries, the heterogeneous nature of blood and the application of such principles in flow chambers designed to expose blood elements to defined flow conditions. The relationship to flow in the normal and diseased vascular system will also be considered. A basic Fluid Dynamics Course is recommended. Instructor permission required.
Prerequisite(s): [(BME 500)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 582
Advanced Mass Transport for Biomedical Engineers
This course is primarily focused on the development of theoretical and mathematical principles necessary for the delineation of mass transport processes in biological & medical systems. The content includes heterogeneous reactions that occur at or in the vicinity of cells or vascular structures under applied laminar flow and transport across cell membranes and within tissues.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 585
Computational Models of the Human Cardiovascular System
This course will focus on the use of computational fluid dynamics for the modeling and analysis of the human cardiovascular system. The course will cover both computational methods for fluid dynamics and biomedical aspects of the human cardiovascular system. Computer models for the simulation and analysis of hemodynamic phenomena will be developed. Requires an Introductory fluid dynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

BME 591
Research and Thesis for Master of Science Degree
Research and thesis for master of science degree students. Instructor permission required.
Credit: Variable

BME 594
Special Projects
Special projects.
Credit: Variable

BME 595
Seminar in Biomedical Engineering
Current research and development topics in biomedical engineering as presented by outside speakers, faculty and advanced students.
Lecture: 0 **Lab:** 0 **Credits:** 3

BME 597
Special Problems
Special problems.
Credit: Variable

BME 691
Research and Thesis PHD
Research and Thesis for PhD degree. (variable credit)
Credit: Variable

Master of Biomedical Engineering

The overall objective of the Master of Biomedical Engineering degree is to provide training relevant to professional employment in a biomedical engineering related field. The student must have a minimum 3.0/4.0 GPA in an engineering or science bachelor's program to be admitted. Candidates should have prior technical coursework that will provide proficiency in areas that are relevant to the field of biomedical engineering.

Curriculum

BME 500	Introduction to Biomedical Engineering	3
BME 533	Biostatistics	3
BME 553	Quantitative Physiology	3
Select two life science and/or advanced mathematics courses		6
Select five engineering and/or computer science courses, of which at least two are BME courses		15
Total Credit Hours		30

Master of Science in Biomedical Engineering

The overall objective of the Master of Science in Biomedical Engineering degree is to provide training relevant to professional employment in a BME-related field. A minimum total of 32 credit hours is required for this degree, of which at least 24 credit hours must come from coursework; 6-8 credit hours of research are required. This degree requires completion of a written dissertation and a subsequent oral defense of it before an approved master's thesis examination committee.

Admission Criteria

Because the M.S. degree requires the time and frequently the resources of a faculty mentor to be available in order to adequately execute the research component of the degree, the BME department will admit candidates who not only have the credentials suitable for this degree but for which a department faculty member consents to serve as the candidate's research mentor.

Curriculum

Required Courses		(24)
BME 500	Introduction to Biomedical Engineering	3
BME 533	Biostatistics	3
BME 553	Quantitative Physiology	3
Select two life science and/or advanced mathematics courses		6
Select three engineering and/or computer science courses, of which at least two are BME courses		9
Thesis Research		(6-8)
BME 591	Research and Thesis for Master of Science Degree	6-8

Minimum degree credits required: 32

Doctor of Philosophy in Biomedical Engineering

This degree is awarded in recognition of a high level of mastery in subject matter and a significant original research contribution in biomedical engineering. The Ph.D. recipient will be capable of a continuing effort toward the advancement of knowledge and achievement in research and other scholarly activities and may pursue a career in a medical, industrial, or academic environment.

A minimum of 72 credit hours is required for the Ph.D. in Biomedical Engineering. Students who have received an M.S. degree from another university may petition for transfer of up to 32 credit hours applicable toward the Ph.D. degree. Students must pass the Ph.D. qualifying examination within the first year of full-time Ph.D. studies. This is a written and oral examination intended to explore both the depth and breadth of the student's academic abilities. Within two and one-half years of matriculation, students will be required to defend their thesis research proposal (comprehensive examination). A written dissertation and oral defense are also required for receiving the doctoral degree. Dissertation format and deadlines are established by the Graduate College.

There are no specific courses that are required for the doctoral degree in biomedical engineering. However, a minimum of three courses in life science, three courses in mathematics, and six courses in biomedical engineering or other engineering-related courses are required. The specific courses selected to meet these requirements will depend on the entering qualifications of the student and the nature of the thesis research proposal. In general, the student's thesis committee will determine the specific course requirements necessary for graduation. Graduate students should consult with their advisers to plan their curriculum.

Curriculum

Minimum Credits Required	72
Maximum 400-Level Credit	3
Maximum Transfer Credit	32

Life Science Courses			(9-10)
Select a minimum of three courses from the following:			9-10
BIOL 403	Biochemistry	4	
BIOL 414	Genetics for Engineering Scientists	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 445	Cell Biology	3	
BIOL 512	Advanced Biochemistry	3	
BIOL 515	Molecular Biology	3	
BIOL 527	Immunology and Immunochemistry	3	
BIOL 550	Bioinformatics	3	
Mathematics Courses			(9)
Select a minimum of three courses from the following:			9
CHE 535	Applications of Mathematics to Chemical Engineering	3	
CHE 536	Computational Techniques in Engineering	3	
MATH 461	Fourier Series and Boundary-Value Problems	3	
MATH 476	Statistics	3	
MATH 489	Partial Differential Equations	3	
MATH 512	Partial Differential Equations	3	
MATH 519	Complex Anyalysis	3	
MATH 532	Linear Algebra	3	
MATH 542	Stochastic Processes	3	
MATH 546	Introduction to Time Series	3	
MATH 555	Tensor Analysis	3	
MATH 564	Applied Statistics	3	
MATH 577	Computational Mathematics I	3	
MATH 578	Computational Mathematics II	3	
MATH 581	Finite Element Method	3	
MMAE 501	Engineering Analysis I	3	
MMAE 502	Engineering Analysis II	3	
MMAE 503	Advanced Engineering Analysis	3	
MMAE 517	Computational Fluid Dynamics	3	
PHYS 501	Methods of Theoretical Physics I	3	
PHYS 502	Methods of Theoretical Physics II	3	
Biomedical Engineering or Other Engineering-Related Courses			(11-20)
Select a minimum of six courses from the following:			11-20
BME 500	Introduction to Biomedical Engineering	3	
BME 501	Communication Skills in Biomedical Engineering	3	
BME 503	Mathematical and Statistical Methods for Neuroscience I	2	
BME 504	Neurobiology	2	
BME 505	Mathematical and Statistical Methods for Neuroscience II	2	
BME 506	Computational Neuroscience II: Vision	3	
BME 507	Cognitive Neuroscience	2	
BME 508	Mathematics and Statistics for Neuroscience III	2	
BME 509	Vertebrate Neural Systems	3	
BME 518	Reaction Kinetics for Biomedical Engineering	3	
BME 521	Medical Imaging	3	

BME 522	Mathematical Methods in Biomedical Engineering	3
BME 523	Cell Biomechanics: Principles and Biological Processes	3
BME 524	Quantitative Aspects of Cell andTissue Engineering	3
BME 530	Inverse Problems in Biomedical Imaging	3
BME 532	Medical Imaging Science	3
BME 533	Biostatistics	3
BME 535	Magnetic Resonance Imaging	3
BME 537	Introduction to Molecular Imaging	3
BME 538	Neuroimaging	3
BME 540	Wave Physics and Applied Optics for Imaging Scientists	3
BME 542	Advanced Concepts in Image Science	3
BME 543	Bioinstrumentation and Electronics	3
BME 551	Physiological Signal Processing and Control Theory	2
BME 552	Control Systems for Biomedical Engineers	3
BME 553	Quantitative Physiology	3
BME 575	Neuromechanics of Human Movement	3
BME 581	Fluid Mechanics for Biomedical Engineers	3
BME 582	Advanced Mass Transport for Biomedical Engineers	3
BME 585	Computational Models of the Human Cardiovascular System	3
BME 595	Seminar in Biomedical Engineering	3
BME 597	Special Problems	1-6
CHE 555	Polymer Processing	3
CHE 575	Polymer Rheology	3
CHE 577	Bioprocess Engineering	3
CHE 582	Interfacial and Colloidal Phenomena with Applications	3
CHE 583	Pharmaceutical Engineering	3
CHE 585	Drug Delivery	3
CS 480	Artificial Intelligence Planning and Control	3
CS 525	Advanced Database Organization	3
CS 580	Topics in Machine Learning	3
CS 583	Probabilistic Graphical Models	3
ECE 511	Analysis of Random Signals	3
ECE 565	Computer Vision and Image Processing	3
ECE 566	Statistical Pattern Recognition	3
ECE 567	Statistical Signal Processing	3
MMAE 510	Fundamentals of Fluid Mechanics	4
MMAE 512	Dynamics of Viscous Fluids	4
MMAE 517	Computational Fluid Dynamics	3
MMAE 579	Advanced Materials Processing	3
General Electives		(0-18)
Select 0-18 credit hours of electives from BME 400-799 to fulfill minimum total credits		0-18
Ph.D. Research		(24-36)
BME 691	Research and Thesis PHD	24-36

Minimum degree credits required: 72

Chemical and Biological Engineering

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Chair
Sohail Murad

Faculty with Research Interests
For more information regarding faculty visit the Department of Chemical and Biological Engineering website.

The mission of the Department of Chemical and Biological Engineering is to meet the present and future needs of society and industry by providing state-of-the-art education and research programs. In order to accomplish this mission, the department provides graduate students with:

- Fundamental knowledge and design capability in chemical and biological engineering
- Advanced research programs in core competency areas
- Knowledge of industrial ecology/design for the environment
- Understanding of ethical, economic, and social issues that influence intellectual technological choices
- Leadership and communication skills
- Lifelong learning capabilities

Research Centers and Institutes

Center for Electrochemical Science and Engineering
Jai Prakash, Director

Center of Excellence in Polymer Science and Engineering
David Venerus, Director

Engineering Center for Diabetes Research and Education
Ali Cinar, Director

Center for Molecular Study of Condensed Soft Matter
Jay Schieber, Director

Center for Complex Systems and Dynamics
Fouad Teymour, Director

Wanger Institute for Sustainable Energy Research
Hamid Arastapoor, Director

Research Facilities

Research facilities of the department include:

- Biochemical Engineering Lab
- Biointerfaces Lab
- Biomaterials Lab
- Center for Electrochemical Science and Engineering Lab
- Center of Excellence in Polymer Science and Engineering Lab
- Computational Fluid Dynamics Lab
- Fuel Cell Lab
- Fuel Cell Battery Lab
- Fluidization Lab
- Gas Processing Lab
- Interfacial Phenomena Lab

- Light Scattering Lab
- Multiphase Flow and Fluidization Lab
- Particle Technology Lab
- Polymer Characterization Lab
- Polymer Reaction Engineering Lab
- Porous Media and Core Analysis Lab
- Process Control & Optimization Lab
- Process Modeling, Monitoring and Control Lab
- Rheology Lab
- Riser Lab
- Hydrogen Storage Lab

The computational facilities of the department include the Advanced Computer Laboratory, and the computer facilities of each research group. All computers are connected to the university computer network by ethernet. Both the PCs and workstations access the multimedia system to provide data visualization and high-quality presentations. Each research lab also has specialized computer facilities. The computational capability for the department is provided by three servers that include both Linux and Windows. Students also have access to the university's computing and network services.

Research Areas

Faculty members conduct numerous projects in the department's core areas of research competency:

Energy and Sustainability

Fuel cells and batteries
Fluidization and gasification
Hybrid systems

Biological Engineering

Molecular modeling
Diabetes
Biomedical and pharmaceutical engineering
Biochemical engineering
Food processing

Advanced Materials

Interfacial and transport phenomena
Nanotechnology
Polymers
Biomaterials

Systems Engineering

Complex systems
Advanced process control
Process monitoring

Energy/Environment/Economics (E3)

Faculty Adviser
Chemical and Biological Engineering
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The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental and sustainability issues and economic forces that drive technology choice.

The E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project or additional energy and sustainability courses for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, of sustainability issues related to energy extraction, conversion, and utilization, and of the impact of sustainability principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of sustainability and regulatory issues to enable them to make more viable technology choices.

Admission Requirements

Cumulative undergraduate GPA: 3.0/4.0

GRE score minimum:

MAS

1. 900 (quantitative + verbal), 2.5 (analytical writing)
2. After August 2011: 295 (quantitative + verbal), 2.5 (analytical writing)

M.S.

1. 900 (quantitative + verbal), 2.5 (analytical writing)
2. After August 2011: 304 (quantitative + verbal), 3.0 (analytical writing)

Ph.D.

1. 1000 (quantitative + verbal), 3.0 (analytical writing)
2. After August 2011: 304 (quantitative + verbal), 3.0 (analytical writing)

TOEFL minimum score: 550/213/80[1]

Note: the GRE requirement is waived for professional master's degree applicants who hold a bachelor of science in a related field from an ABET-accredited university in the United States with a minimum cumulative GPA of 3.0/4.0

Certificate program applicants must possess a bachelor's degree with a minimum cumulative GPA of 2.5 on a 4.0 scale. The GRE is not required.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. Admission to graduate study in chemical engineering or biological engineering normally requires the completion of a program leading to a bachelor's degree in chemical engineering or another engineering discipline from an accredited institution. Depending on the student's background, deficiency courses, some of which may not count toward the degree, may be required. Please see the department's list of applicable undergraduate courses.

Admission to the graduate degree program in biological engineering requires one college-level semester of biology. Students not meeting this requirement may be admitted, but will have to take CHE 412 to remove the deficiency.

1 Paper-based test score/computer-based test score/internet-based test score.

Degree Programs

- Master of Biological Engineering (p. 53)
- Master of Chemical Engineering (p. 53)
- Master of Science in Chemical Engineering (p. 54)
- Doctor of Philosophy in Chemical Engineering (p. 55)

Dual Degree Program

- Master of Science in Computer Science/Master of Chemical Engineering (with Computer Science) (p. 54)

Interdisciplinary Programs

- Master of Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 56)
- Master of Science in Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 58)
- Doctor of Philosophy of Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 59)

Certificate Programs

The department offers six graduate certificate programs. These programs provide students with post-baccalaureate knowledge of an area of specialization within chemical engineering. Students in these programs register as certificate students.

Certificate programs typically require a set of three to four courses that must be completed in three years with a minimum GPA of 3.0/4.0. (Note: some courses may have prerequisites.) Students who are admitted to master's degree programs may apply coursework previously taken in a certificate program toward the requirements for the master's degree.

Course Descriptions

CHE 503
Thermodynamics
Laws of thermodynamics applied to chemical and biological engineering problems, properties of real fluids, phase and chemical equilibria, applications to chemical and biological processes and auxiliary equipments. Core course.
Prerequisite(s): [(CHE 351 and CHE 451)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 506
Entrepreneurship and Intellectual Property Management
Graduate standing or consent of instructor. This course aims to introduce and develop a number of diversified professional skills necessary for success in an engineering research and development environment. Selected topics covered in the areas of technology entrepreneurship, opportunity assessment, creativity and innovation, project management, management of organizational change, entrepreneurial leadership, and intellectual property management.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 508
Process Design Optimization
Organization of the design problem and application of single and multi-variable search techniques using both analytical and numerical methods.Prerequisite:An undergraduate course in process design.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 516
Technologies for Treatment of Diabetes
Study of physiological control systems and engineering of external control of biological systems by focusing on an endocrine system disorder -- diabetes. The effects of type 1 diabetes on glucose homeostasis and various treatment technologies for regulation of glucose concentration. Development of mathematical models describing the dynamics of glucose and insulin concentration variations, blood glucose concentration measurement and inference techniques, insulin pumps, and artificial pancreas systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 525
Chemical Reaction Engineering
Advanced treatment of chemical kinetics and reactor systems including non-isothermal, nonideal flow systems. Modeling of complex reactions, catalysis and heterogeneous reactor analysis. Reactor stability concepts. Core course.
Prerequisite(s): [(CHE 423)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 530
Advanced Process Control
State space, transfer function and discrete-time representations of process systems. Control system design. Interaction assessment. Multivariable and model predictive-control techniques. Core course.
Prerequisite(s): [(CHE 435)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 535
Applications of Mathematics to Chemical Engineering
Mathematical techniques and their application to the analytical and numerical solution of chemical engineering problems. The analytical component includes review of matrices and determinants, as well as solution of ordinary, partial differential and integral equations. The numerical component includes iterative solution of algebraic equations, numerical analysis and solution of ordinary differential equations. Core course.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 536
Computational Techniques in Engineering
Advanced mathematical techniques, numerical analysis, and solution to problems in transport phenomena, thermodynamics, and reaction engineering. Review of iterative solution of algebraic equations. Nonlinear initial and boundary value problems for ordinary differential equations. Formulation and numerical solution of parabolic, elliptic, and hyperbolic partial differential equations. Characteristics, formulation, and numerical solution of integral equations. Solution of transient two-phase flow problems using CFD codes.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 538
Polymerization Reaction Engineering
The engineering of reactors for the manufacture of synthetic polymeric materials, commercial processes for manufacture of polymers of many types, polymer chemistry and engineering reactor design.
Prerequisite(s): [(CHE 423)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 541
Renewable Energy Technologies
The course will cover three topics related to renewable Energy Technologies. 1. Review of renewable energy sources; solar, wind, biomass, etc. 2. Energy storage and conversion with emphasis on batteries and fuel cells 3. Hydrogen as an energy carrier and the Hydrogen Economy.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 542
Fluidization and Gas-Solids Flow Systems
Fluidization phenomena (bubbling, slugging, elutriation, and jets in fluidized beds). Multiphase flow approach to fluidization and gas/solids flow systems. Kinetic theory approach to fluid/particle flow systems. Analysis of flow of particles in pneumatic conveying lines (dilute flow) and stand pipe (dense flow). Hydrodynamic analysis of spouted and circulating fluidized beds. Examples from current literature on applications of multiphase flow.
Prerequisite(s): [(CHE 501 and CHE 535)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 543
Energy, Environment, and Economics
The linkage of energy, environmental and economic issues. The impact of energy supply and end use on human well-being and the ecosystem. A comprehensive approach to the resolution of resource, technical, economic, strategic, environmental, socio- and geopolitical problems of the energy industries. Pathways to a sustainable global energy system.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 545
Metabolic Engineering
Cellular metabolism, energetics and thermodynamics of cellular metabolism, regulation of metabolic pathways, metabolic flux analysis, metabolic control analysis, analysis of metabolic networks, synthesis and manipulations of metabolic pathways, applications - case studies.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 551
Advanced Transport Phenomena
Formulation, solution and interpretation of problems in momentum, energy and mass transport phenomena that occur in chemical and biological processes.
Prerequisite(s): [(CHE 406)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 553
Advanced Thermodynamics
Advanced thermodynamics for research-oriented graduate students. The course covers the fundamental postulates of thermodynamics and introductory statistical mechanics, with applications to pure fluids, fluid mixtures, elastic solids, surfaces and macromolecules.
Prerequisite(s): [(CHE 351 and CHE 451)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 555
Polymer Processing
Analysis of momentum, heat and mass transfer in polymer processing operations. Polymer processes considered include extrusion, calendaring, fiber spinning, injection molding, and mixing.
Prerequisite(s): [(CHE 406)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 560
Statistical Quality and Process Control
Basic theory, methods and techniques of on-line, feedback, quality-control systems for variable and attribute characteristics. Methods for improving the parameters of the production, diagnosis and adjustment processes so that quality loss is minimized. Same as MMAE 560.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 565
Fundamentals of Electrochemistry
Thermodynamics and potential, Marcus theory, charge transfer kinetics and mass transport of simple systems. Electrode reactions couple with homogeneous chemical reactions. Double layer structure and adsorbed intermediates in electrode processes. Potential step and potential sweep methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 566
Electrochemical Engineering
Basic concepts of electrochemistry used in electrochemical reactor analysis and design. Thermodynamics, kinetics and transport processes in electrochemical systems, current and potential distribution, corrosion engineering, electrodeposition, batteries and fuel cells, industrial electrolysis, and electrosynthesis.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 567
Fuel Cell Fundamentals
A detailed study of the thermodynamics, electrochemistry, electrode kinetics and materials aspects of fuel cells with an emphasis on polymer electrolyte fuel cells. The course will include a vigorous laboratory component and will cover the development of detailed data analysis procedures. A part of the course will cover current trends and interests through the critical discussion of recent archival publications.
Lecture: 2 **Lab:** 1 **Credits:** 3

CHE 575
Polymer Rheology
Flow of viscoelastic fluids, integral and differential constitutive equations from continuum and molecular considerations, methods of experimental evaluations.
Prerequisite(s): [(CHE 406)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 577
Bioprocess Engineering
Application of engineering principles to the biological production processes. Enzyme kinetics, cell culture kinetics, transport phenomena in cells, membranes, and biological reactors ,genetics, bioseparation and downstream processing, energetics of metabolic pathways, operation modes of cell cultures, mixed and their applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 580
Biomaterials
Metal, ceramic, and polymeric implant materials. Structure-property relationships for biomaterials. Interactions of biomaterials with tissue. Selection and design of materials for medical implants.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 582
Interfacial and Colloidal Phenomena with Applications
Applications of the basic principles of physical chemistry, surfactants and interfacial phenomena, surface and interfacial tension, adsorption of surfactants from solutions, spreading, contact angles, wetting, electro kinetic phenomena, rheology, dynamic interfacial properties, mass transport across interfaces. Applications include emulsions, foams, dispersions, tribology, detergency, flotation, enhanced oil recovery, suspension, emulsion polymerization and liquid membranes.
Prerequisite(s): [(CHE 351) OR (CHE 451)]AND[(CHE 406)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 583
Pharmaceutical Engineering
Application of transport phenomena, and reaction engineering to pharmaceutical processes. Heat and mass transfer in bioreactors and the fluidized beds. Drying, coating and granulation. Environmental and economical issues in the pharmaceutical process. Examples from industrial processes and current literature.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 584
Tissue Engineering
Growth and differentiation of cells and tissue. In vitro control of tissue development. In vivo synthesis of tissues and organs. Transplantation of engineered cells and tissue. Techniques and clinical applications of tissue engineering.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 585
Drug Delivery
Principle of diffusion in liquids membrane and polymers, and methods for measurement and analysis of diffusion coefficient. Principle of molecular transport in polymeric material, and drug solubility in polymers. Intravenous infusion, and polymer drug delivery systems. Process involved and kinetics of solute release. Design and optimization of drug delivery system based on pharmacokinetic/ pharmacodynamic requirements.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHE 591
Research and Thesis for M.S. Degree
Credit: Variable

CHE 593
Seminar in Chemical Engineering
Presentations on recent developments in the field by academic and industrial visitors.
Lecture: 0 **Lab:** 0 **Credits:** 1

CHE 594
Special Projects
Advanced projects involving computer simulation, modeling or laboratory work. (Credit: 1-6 hours.)
Credit: Variable

CHE 597
Special Problems
Independent study and project. (Credit: variable)
Credit: Variable

CHE 600
Continuance of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

CHE 691
Research and Thesis for Ph.D. Degree
Credit: Variable

Master of Biological Engineering

The objective of this degree program is to prepare students for professional practice in any field of engineering involving biological processes, and to provide a foundation in the fundamental knowledge of biological engineering. The student must have a minimum grade point average of 3.0/4.0 in the core areas. Candidates are required to take a total of 30 credit hours: 9 credit hours of core courses, 7 credit hours of required biology courses, 3 credit hours of a required professional course, and 11 credit hours of electives.

Curriculum

Core Courses			(9)
CHE 406	Transport Phenomena [1]		3
CHE 503	Thermodynamics [1]		3
CHE 577	Bioprocess Engineering [1]		3
Biology Requirements			(6)
BIOL 504	Biochemistry		3
BIOL 515	Molecular Biology		3
Professional Requirement			(3)
CHE 506	Entrepreneurship and Intellectual Property Management		3
Electives			(12)
Select 12 credit hours from the following:			12
BME 525	Microfluidics for Biomedical Engineering	3	
BME 533	Biostatistics	3	
CHE 545	Metabolic Engineering	3	
CHE 580	Biomaterials	3	
CHE 583	Pharmaceutical Engineering	3	
CHE 584	Tissue Engineering	3	
CHE 585	Drug Delivery	3	
CHE 593	Seminar in Chemical Engineering	1	
CHE 597	Special Problems	1-20	
ENVE 513	Biotechnological Processes in Environmental Engineering	3	
Select any 500-level Food Process Engineering course (p. 365)		3	
Other approved electives from CHE, CHEM, BME, BIOL			
Total Credit Hours			30

1 A minimum grade point average of 3.0/4.0 is required for core courses.

Master of Chemical Engineering

Project option

The objective of this degree program is to prepare students for professional practice in the field of chemical engineering, and to provide a foundation in the fundamental knowledge of chemical engineering.

Candidates are required to take a total of 30 credit hours: 12 credit hours of core courses, 3 credit hours of a required professional course, and 15 credit hours of electives. Elective courses are to be determined in consultation with an academic adviser.

Curriculum

Core Courses		(12)
CHE 406	Transport Phenomena [1]	3
CHE 503	Thermodynamics [1]	3
CHE 525	Chemical Reaction Engineering [1,2]	3
CHE 530	Advanced Process Control [1]	3
or CHE 535	Applications of Mathematics to Chemical Engineering	
Professional Requirment		(3)
CHE 506	Entrepreneurship and Intellectual Property Management	3
Elective Courses		(15)

Select 15 credit hours	15
Total Credit Hours	30

[1] A minimum grade point average of 3.0/4.0 is required in the core courses.

[2] Note: Interested students can substitute CHE 577 for CHE 525 with adviser consent.

Master of Science in Chemical Engineering

The objective of this degree program is to enable the student to build a strong foundation in multiple areas of chemical engineering and to specialize in one area via research and thesis. Candidates are required to take a total of 32 credit hours: 12 credit hours of which must be for the chemical engineering core courses, and 6-8 credit hours must be in research and thesis work. Elective courses are to be determined in consultation with an academic adviser.

Curriculum

Core Courses		(12)
CHE 525	Chemical Reaction Engineering	3
CHE 535	Applications of Mathematics to Chemical Engineering	3
CHE 551	Advanced Transport Phenomena	3
CHE 553	Advanced Thermodynamics	3
Thesis Research		(6-8)
CHE 591	Research and Thesis for M.S. Degree	6-8
Elective Courses		(12-14)
Select 12 to 14 credit hours		12-14

Minimum degree credits required: 32

A minimum grade point average of 3.0/4.0 is required for core courses. Aside from the core courses, coursework may be selected (with adviser approval) to satisfy the needs of the individual student and may be aligned with the research areas listed in the Department of Chemical and Biological Engineering section (p. 47) of this bulletin.

A thesis may be completed outside the department only by special arrangement with the department chair. The successful M.S. degree candidate will complete a thesis based on research as well as an oral defense of the thesis, under the direction of the thesis examining committee.

Master of Science in Computer Science/Master of Chemical Engineering

Collaborative Program with the Department of Computer Science

This combined program in computer science and chemical engineering addresses the growing need for process engineers with expertise in computational modeling and simulation of chemical processes. Similarly, the program provides a strong engineering background that is required today in many areas of computer science. The program is jointly offered by the Department of Computer Science and the Department of Chemical and Biological Engineering. Students in this program earn both Master of Science in Computer Science and Master of Chemical Engineering degrees.

Students must fulfill the core course requirements of both departments. Students are required to take 18 credit hours in graduate chemical engineering courses (courses numbered 500 or higher) and 26 credit hours in computer science courses (of which 20 credit hours must be 500-level courses).

Curriculum

Code	Title		Credit Hours
Chemical Engineering Courses			(18)
CHE 406	Transport Phenomena		3
CHE 503	Thermodynamics		3
CHE 525	Chemical Reaction Engineering		3
CHE 535	Applications of Mathematics to Chemical Engineering		3
Select a minimum of two courses from the following:			6
CHE 508	Process Design Optimization	3	

CHE 530	Advanced Process Control	3	
CHE 536	Computational Techniques in Engineering	3	
CHE 560	Statistical Quality and Process Control	3	
Any other 500-level course must be approved by the academic adviser			
Computer Science Courses			(26)
Students are required to take at least one course in each of the three core areas (Programming, Systems, and Theory) and 17 credit hours of computer science elective coursework			26
Programming Core Courses			
CS 511	Topics in Computer Graphics	3	
CS 512	Computer Vision	3	
CS 525	Advanced Database Organization	3	
CS 540	Syntactic Analysis of Programming Languages	3	
CS 541	Topics in Compiler Construction	3	
CS 546	Parallel and Distributed Processing	3	
CS 551	Operating System Design and Implementation	3	
CS 553	Cloud Computing	3	
Systems Core Courses			
CS 542	Computer Networks I: Fundamentals	3	
CS 544	Computer Networks II: Network Services	3	
CS 547	Wireless Networking	3	
CS 550	Advanced Operating Systems	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 570	Advanced Computer Architecture	3	
CS 586	Software Systems Architectures	3	
Theory Core Courses			
CS 530	Theory of Computation	3	
CS 533	Computational Geometry	3	
CS 535	Design and Analysis of Algorithms	3	
CS 536	Science of Programming	3	
CS 538	Combinatorial Optimization	3	
CS 539	Game Theory: Algorithms and Applications	3	
Total Credit Hours			44

Doctor of Philosophy in Chemical Engineering

The doctoral degree in chemical engineering is awarded in recognition of mastery in chemical/biological engineering and upon demonstration of an ability to make substantial creative contributions to knowledge in chemical engineering. The recipients of these degrees will be capable of a continuing effort toward advancement of knowledge and achievement in research while pursuing an academic or industrial research career.

Curriculum

Minimum Credits Required	72
Maximum Transfer Credit	32

Core Courses		(15) [1]
CHE 525	Chemical Reaction Engineering [1]	3
CHE 530	Advanced Process Control [1]	3
or CHE 536	Computational Techniques in Engineering	
CHE 535	Applications of Mathematics to Chemical Engineering [1]	3
CHE 551	Advanced Transport Phenomena [1]	3
CHE 553	Advanced Thermodynamics [1]	3
Elective Courses		(21-33)
Select 21-33 credit hours of electives [2]		21-33
Ph.D. Research		(24-36)

CHE 691	Research and Thesis for Ph.D. Degree	24-36

[1] A minimum grade point average of 3.0/4.0 is required in the core courses.
[2] The upper limit for independent study coursework (CHE 597) is 18 credit hours.

Students should consult the Transfer Credit (p. 476) section of this bulletin for rules on how many credit hours may be transferred from another institution.

Students must pass a written qualifying examination within three semesters after they have been admitted to the Ph.D. program. The exam is diagnostic in nature, and the results of the exam will determine the student's potential for success in the Ph.D. program and recommendations for a future program of study. The examination will cover four core areas: thermodynamics, reaction engineering and kinetics, transport phenomena, and process modeling and control.

The comprehensive examination is oral and may include a written exam based on the student's performance on the qualifying exam. The exam questions will be formulated by the members of the Ph.D. examining committee. The examination will also include oral presentation and discussion by the student of a journal article selected a priori by the examining committee. The exam must be conducted within a year following completion of the qualifying exam. The Ph.D. examining committee, which may be the same as the Ph.D. thesis committee, should be suggested by the adviser and approved by the chairperson at least three weeks prior to the examination.

The thesis proposal examination, which is diagnostic in nature, should be conducted after the comprehensive exam and at least one year before the final thesis defense. The exam will be oral and will be administered by the Ph.D. thesis committee.

Doctoral research can begin after admission to the Ph.D. program. However, the major portion of the research should not be started until the comprehensive examination is passed and the thesis proposal is approved by the committee. All research must be conducted under the supervision of a full-time department faculty member and in the laboratories of the university. Off-campus research is possible with the approval of the department chairperson. The preliminary thesis draft must meet the approval of all members of the examination committee. An oral examination in defense of the thesis is given as an open university seminar. The thesis defense must meet with the approval of the examination committee; if it does not, the committee has the authority to determine whether or not to grant a re-examination.

Master of Chemical Engineering with Specialization in Energy/Environment/Economics (E3)

This program has the same requirements as the M.S. degree program, except that in place of 6-8 credit hours of M.S. thesis research, students are required to register for 2-5 credit hours of special projects research (CHE 594), plus additional E3 courses with the approval of their adviser. Students are also encouraged to register or attend the interdisciplinary graduate seminar (CHE 593) or general seminars offered in energy and/or sustainability areas by the Wanger Institute for Sustainable Energy Research (WISER).

Curriculum

Code	Title	Credit Hours
Core Courses		(12)
CHE 525	Chemical Reaction Engineering	3
CHE 535	Applications of Mathematics to Chemical Engineering	3
CHE 551	Advanced Transport Phenomena	3
CHE 553	Advanced Thermodynamics	3
Special Projects Research		(2-5)
CHE 594	Special Projects	2-5
E3 Courses		(9)
CHE 543	Energy, Environment, and Economics	3
Select a minimum of one course from Group A		3
Select a minimum of one course from Group B		3
Electives		(5-8)
Select 5 to 8 credit hours		5-8
Recommended		(1)
CHE 593	Seminar in Chemical Engineering (or general seminars offerend in energy and/or sustainability by WISER)	1

Minimum degree credits required: 32

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Science in Chemical Engineering with Specialization in Energy/Environment/Economics (E3)

Students pursuing the M.S. in Chemical Engineering with E3 specialization are required to take CHE 543 and select at least one course from Group A and one course from Group B, and register for 6-8 credit hours of M.S. thesis preparation (CHE 591) in an interdisciplinary E3 area. In addition, the students are required to take all required core courses for the M.S. in Chemical Engineering degree.

Students may apply up to 12 credit hours of 400-level courses to the M.S. degree requirements with their adviser's approval. Students are also encouraged to register or attend the interdisciplinary graduate seminar (CHE 593) or general seminars offered in energy and/or sustainability areas by the Wanger Institute for Sustainable Energy Research (WISER).

Curriculum

Code	Title	Credit Hours
Core Courses		(12)
CHE 525	Chemical Reaction Engineering [1]	3
CHE 535	Applications of Mathematics to Chemical Engineering [1]	3
CHE 551	Advanced Transport Phenomena [1]	3
CHE 553	Advanced Thermodynamics [1]	3
E3 Courses		(9)
CHE 543	Energy, Environment, and Economics	3
Select one course from Group A		3
Select one course from Group B		3
Thesis Research		(6-8)
CHE 591	Research and Thesis for M.S. Degree	6-8
Electives		(2-4)
Select 2 to 4 credit hours		2-4
Recommended		(1)
CHE 593	Seminar in Chemical Engineering (or general seminars offered in energy and/or sustainability by WISER)	1

Minimum degree credits required: 32

[1] A minimum grade point average of 3.0/4.0 is required for core courses.

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3

ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Doctor of Philosophy in Chemical Engineering with Specialization in Energy/Environment/Economics (E3)

Students interested in the Ph.D. program in chemical engineering are required to take at least 72 credit hours beyond the B.S. degree requirements, including required chemical engineering core courses for the Ph.D. in Chemical Engineering, CHE 543, and at least five E3 courses (from Groups A and/or B). Registration for approximately 24 credit hours of Ph.D. thesis research in E3 areas of study is also required. Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one professor with specialization in an energy and sustainability area from outside the student's department. The students are also encouraged to register or attend the interdisciplinary graduate seminar (CHE 593) or general seminars offered in energy and/or sustainability areas by the Wanger Institute for Sustainable Energy Research (WISER).

Curriculum

Code	Title	Credit Hours
Core Courses		(33)
CHE 525	Chemical Reaction Engineering	3
CHE 530	Advanced Process Control	3
or CHE 536	Computational Techniques in Engineering	
CHE 535	Applications of Mathematics to Chemical Engineering	3
CHE 551	Advanced Transport Phenomena	3
CHE 553	Advanced Thermodynamics	3
CHE 543	Energy, Environment, and Economics	3
Select 5 E3 courses from Groups A and/or B		15
Ph.D. Research		(24)
Register for 24 hours of Ph.D. thesis research in E3 areas of study		24

Minimum degree credits required: 72

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Certificate in Biological Engineering

This program provides an introduction to the field of biological engineering and its application in biological, biomedical, and environmental processes.

Curriculum

Required Courses		(12)
CHE 577	Bioprocess Engineering	3
Select a minimum of three courses from the biology requirements and the elective courses listed under the Master of Biological Engineering (p. 53)		9
Total Credit Hours		12

Certificate in Current Energy Issues

This program explores issues related to the establishment of sustainable energy systems including energy/environment/economics, renewable energy, batteries, and fuel cells.

Curriculum

Required Courses			(9)
Select a minimum of three courses from the following:			9
CHE 541	Renewable Energy Technologies	3	
CHE 542	Fluidization and Gas-Solids Flow Systems	3	
CHE 543	Energy, Environment, and Economics	3	
CHE 565	Fundamentals of Electrochemistry	3	
CHE 567	Fuel Cell Fundamentals	3	
Total Credit Hours			9

Certificate in Particle Processing

This program provides an introduction to the field of particle processing, specifically in fluidization and fluid/particle systems. Fundamentals of fluid/particle system design, computational multiphase approach to gas/particle systems, and advanced measurement techniques are presented.

Curriculum

A minimum of 3 courses (9 credit hours) is required for this certificate.

Select a minimum of one of the following:			3
CHE 489	Fluidization	3	
CHE 542	Fluidization and Gas-Solids Flow Systems	3	
Select one/two of the following:			3-6
CHE 551	Advanced Transport Phenomena	3	
CHE 582	Interfacial and Colloidal Phenomena with Applications	3	

Certificate in Pharmaceutical Engineering

This program develops, expands, and refines skills to advance the technology of prescription drug development and manufacturing. Fundamentals of pharmaceutical engineering, drug delivery systems, and regulatory issues are presented.

Curriculum

A minimum of four courses (12 credit hours) are required for this certificate.

Required Courses			(12)
CHE 545	Metabolic Engineering		3
CHE 560	Statistical Quality and Process Control		3
CHE 583	Pharmaceutical Engineering		3
CHE 585	Drug Delivery		3
Total Credit Hours			12

Certificate in Polymer Science and Engineering

This program introduces fundamentals of polymerization and polymer synthesis, polymer kinetics, polymer processing and characterizations.

Curriculum

A minimum of four courses (12 credit hours) are required for this certificate.

Required Courses			(12)
CHE 470	Introduction to Polymer Science		3
Select a minimum of three courses from the following:			9
CHE 538	Polymerization Reaction Engineering	3	
CHE 555	Polymer Processing	3	
CHEM 535	Polymer Synthesis	3	
CHEM 542	Polymer Characterization and Analysis	3	
Total Credit Hours			12

Certificate in Process Operations Management

This program introduces methodology and tools to improve the technical management of process operations including process modeling, simulation, monitoring, control and optimization.

Curriculum

A minimum of four courses (12 credit hours) are required for this certificate.

Required Courses			(12)
Select at least one of the following groups:			12
I			
CHE 426	Statistical Tools for Engineers	3	
CHE 560	Statistical Quality and Process Control	3	
II			
CHE 435	Process Control	3	
CHE 508	Process Design Optimization	3	
CHE 530	Advanced Process Control	3	
Total Credit Hours			12

Civil, Architectural, and Environmental Engineering

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engineering.iit.edu/caee

Chair
Paul Anderson

Faculty with Research Interests
For more information regarding faculty visit the Department of Civil, Architectural, and Environmental Engineering website.

The Department of Civil, Architectural, and Environmental Engineering offers graduate instruction in structural engineering, transportation engineering, geotechnical engineering, environmental engineering, public works, construction engineering and management, and architectural engineering. The department maintains relationships with business, industry, and government. An active research program provides highly relevant perspectives on current engineering challenges and issues in the field.

Research Facilities

Research facilities include laboratories devoted to concrete structures, structural models, metal structures, materials, architectural engineering, geotechnical engineering, transportation engineering, construction engineering and management, and environmental engineering.

In addition, faculty and graduate students have access to regional facilities such as the Argonne National Laboratory. Also, the department has a computer-aided engineering and design lab equipped with state-of-the-art hardware and software.

Research Areas

The main research areas in the department are architectural engineering, construction engineering and management, environmental engineering, geotechnical engineering, public works, structural engineering, and transportation engineering.

In architectural engineering, faculty conduct research in the built environment, airflow and thermal modeling, indoor air quality, energy and sustainability, and thermal comfort.

Construction engineering and management research involves construction productivity, scheduling and progress control, dispute resolution, construction company organization, sectorial studies, and project management.

Environmental engineering research areas include air pollution, energy and sustainability, hazardous waste engineering, indoor air quality, and wastewater engineering.

Geotechnical research emphasizes soil mechanics, rock mechanics, engineering geology, earthquake engineering, soil structure, and soil-water interactions.

Research in the public works specialty area includes public policy evaluation, management of engineering operations, maintenance, and rehabilitation and construction of civil infrastructures such as roads, bridges, and traffic safety hardware.

Structural engineering research concentrates on structural dynamics and earthquake resistant design, structural health monitoring, computational mechanics, and bridge engineering.

Transportation engineering research areas include multimodal transportation infrastructure and dynamic traffic network mobility, safety, energy consumption and vehicle emission performance modeling; security, evaluation planning and emergency management; transportation asset management, addressing system integration, risk and uncertainty, and sustainability; and network economics.

Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental and sustainability issues and economic forces that drive technology choice.

The E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project or additional energy and sustainability courses for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, of sustainability issues related to energy extraction, conversion, and utilization, and of the impact of sustainability principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of sustainability and regulatory issues to enable them to make more viable technology choices.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0

TOEFL minimum: 550/213/80[1]

ME/M.S.

1. GRE score:
   900 (quantitative + verbal)
   2.5 (analytical writing)
2. New GRE score:
   292 (quantitative + verbal)
   2.5 (analytical writing)

Ph.D.

1. GRE score:
   1000 (quantitative + verbal)
   3.0 (analytical writing)
2. New GRE score:
   292 (quantitative + verbal)
   2.5 (analytical writing)

Note: the GRE requirement is waived for master of engineering degree applicants who hold a bachelor of science in a related field from an ABET-accredited university in the U.S. with a minimum GPA of 3.0/4.0.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of many factors considered.

Admission to graduate degree programs in civil engineering normally requires a bachelor of science degree in civil engineering from an institution accredited by Accreditation Board of Engineering and Technology (ABET). The master's programs in construction engineering and management and in architectural engineering may also accept a bachelor's degree in other relevant engineering disciplines, as well as architecture. Students who have completed an accredited program in a related field or in a foreign school may be admitted on a provisional status until any deficiencies in preparation are removed. Architectural engineering students with a previous degree in architecture are typically required to take deficiency courses (e.g. CAE 208, CAE 209).

Admission to graduate degree programs in environmental engineering requires a bachelor's degree in an appropriate undergraduate field from an accredited institution. Prerequisites for the program are somewhat flexible, but all applicants should have had one year of chemistry and math through differential equations. Qualified applicants with degrees in the life sciences, engineering, and physical sciences will normally be admitted to the program without extensive prerequisites.

Each full-time graduate student is assigned a faculty adviser at the time of initial registration. Part-time or non-degree students who have not been assigned an adviser and who intend to pursue a program toward a degree should contact the department for counseling before registering for courses. Departmental seminars and colloquia (CAE 593) are conducted on a regular basis. All full-time civil and architectural engineering graduate students are expected to register for CAE 593 and attend these seminar meetings regularly for one semester.

1 Paper-based test score/computer-based test score/internet-based test score.

Degree Programs

Interdisciplinary Programs

Certificate Program in Architectural Engineering

Certificate Programs in Civil Engineering

Certificate Programs in Environmental Engineering

Course Descriptions

CAE 502
Acoustics and Lighting
General introduction to the aural and visual environment. Subjective and objective scales of measurement. Laws of psychophysics. Introduction to vibration. The hearing mechanism. Transfer of sound. Passive control of noise in buildings, transmission loss. Absorption and reverberation time. Active control of the aural environment. Visual perception. Photometry, brightness, luminance and illumination. Natural lighting of buildings. Artificial lighting.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 503
Advanced Structural Analysis
Introduction to the mechanics of solids. Energy methods and the calculus of variations. Ritz/Galerkin approximation methods. Introductory discussions on elastic stability and plate analyses.
Prerequisite(s): [(CAE 411) OR (CAE 514*) OR (MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 504
Seismic Retrofit and Earthquake Hazard Reduction
Selection of site-dependent earthquake for retrofit. Strength and ductility of aging structures. Cyclic behavior and modeling of structures under seismic loading. Performance-based retrofit criteria. Evaluating earthquake vulnerability of existing buildings and bridges. Upgrading lateral load-carrying systems. Conceptual basis for seismic isolation and energy-absorbing techniques and their applications in earthquake hazard reduction in existing bridges and buildings. Selection of retrofit methods. Case studies of seismic retrofit of typical buildings, bridges, and industrial facilities using strength upgrading, energy dissipation devices, and base isolation.
Prerequisite(s): [(CAE 529)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 506
Building Envelope Rehabilitation
Repair and rehabilitation of existing building exterior envelopes. The course will include problem identification, investigative techniques, repair methods, preparation of remedial design documents and general management of rehabilitation projects. Types of constructions include buildings, exterior walls, facades, cladding, roofing, plazas, porches, fire escapes, and others.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 507
Control of Sound and Vibration in Buildings
Basic sound physics and sound propagation in enclosed spaces. Sound and vibration sources in and out of buildings. Theories of sound transmission through building elements. Effects of noise and vibration on man and buildings, criteria and standards. Design of noise control systems. Calculation of airborne and impact sound insulation. Noise and vibration control implementations in various indoor spaces, such as residential units, offices, schools and mechanical rooms.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 508
Advanced Bridge Engineering
Specifications for bridge design and evaluation. Advanced bridge design and evaluation topics such as design load envelope, seismic load design, bridge condition rating, bridge load rating, and steel bridge fatigue evaluation. Bridge management systems. Life cycle analyses. Use of high performance materials in bridge engineering.
Prerequisite(s): [(CAE 408)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 509
Anlys&Dsgn of Acoustic Spaces
This course will discuss the design of acoustic spaces such as conference rooms, classrooms, lecture halls, music halls, theater, churches, recording studio, and home theater. Course covers the selection and determination of appropriate steady state, spatial, and temporal acoustic measures such as background noise levels, reverberation time, speech transmission index, and interaural cross correlation, as well as the selection of building materials and layout of rooms to meet those requirements.
Prerequisite(s): [(CAE 502) OR (CAE 542)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 510
Dynamics of Fire
Introduction to fire, physics and chemistry, and mass and heat transfer principles, fire fluid mechanic fundamentals, fundamentals and requirements of the burning of materials (gases, liquids, & solids), fire phenomena in enclosures such as pre-flashover and post-flashover.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 511
Fire Protection of Buildings
Fundamentals of building design for fire and life safety. Emphasis on a systematic design approach. Basic considerations of building codes, fire loading, fire resistance, exit design, protective systems & other fire protection systems. For architects, and engineers not majoring in fire protection and safety engineering.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 512
Computer Modeling of Fire
Introduction to fire heat transfer processes and fire testing materials; application of a set of quantitative engineering tools (fire models) to construct a description of conditions that occur or might occur during the course of a fire; life and structural impacts from hostile fires in buildings.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 513
Building Science
Study of the physical interaction of climate (humidity, temperature, wind, sun, rain, snow, etc.) and buildings. Topics include psychrometrics, indoor air quality, indoor thermal comfort, heat transfer, air infiltration, solar insolation, and heating and cooling load calculation.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 514
Mathematical Methods for Structural Engineering
Matrices, linear spaces and transformations, eigenvalue problems, and their application to civil engineering. First-order differential equations for structural dynamics. Calculus of variations and variational principles for dynamics and statics. Rayleigh-Ritz method, finite element approximations, Newmark-Beta method, Green's Function, and Duhamel Integral and their application to civil engineering.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 515
Building Energy Modeling
Building energy modeling (BEM) is the core of building information modeling (BIM) and sustainable design which are changing the way of architectural design and engineering. This course builds essential knowledge of building performance simulation and provides necessary background to use a building energy simulation software tool. Proven methods for using BEM to deal with such essential building performance and sustainability issues will be presented by using real world examples placing particular emphasis on using BEM-enabled quantitative analysis to evaluate design alternatives for the whole life cycle of a building. Complete with coverage of integrated design and lean construction requirements, this is a valuable course for architects, engineers, and construction professionals involved in energy performance modeling for buildings.
Prerequisite(s): [(CAE 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 516
Lighting Systems Design and Analysis
Intensive study of the calculation techniques and quantitative aspects of good luminous design. Topics covered include photometric quantities and color theory, visual perception, IESNA standards, daylight and artificial illumination, radiative transfer, luminaire characteristics, control systems, and energy conservation techniques. Design and analysis problems, field measurements, and use of industry computer simulations for design and luminaire systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 518
Advanced Reinforced Concrete
Mechanical properties of hardened concrete, including creep phenomena. Ultimate strength of columns, beams and beam-columns. Introduction to limit analysis of frames and yield-line analysis of plates.
Prerequisite(s): [(CAE 432*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 520
Buckling of Structures
Review of simple column buckling for various conditions. Basic considerations of stable and unstable equilibrium. Determination of buckling loads of columns with variable cross-section. Analysis of elastic stability of framed structures. Approximate solutions of more complicated problems by various numerical and energy methods. Analysis of lateral and torsional stability of beams and beam-columns. Stability in the inelastic range of columns. Buckling of plates and cylindrical shells.
Prerequisite(s): [(CAE 411 and CAE 431)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 521
Building Illumination Design
An intensive study of the calculation techniques and qualitative aspects of good luminous design. Topics covered include photometric quantities and color theory, visual perception, standards, daylight and artificial illumination systems, radiative transfer, fixture and lamp characteristics, control devices and energy conservation techniques. Design problems, field measurements, computer and other models will be used to explore the major topics.
Prerequisite(s): [(CAE 467) OR (CAE 502) OR (CAE 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 522
Structural Model Analysis
Theory of measurements, statistics, similitude, and model laws and the usefulness of structural models. Displacement and strain measurement techniques. Theory and practice of indirect model analysis. Theory and practice of direct model techniques including photo elasticity and Moire methods.
Prerequisite(s): [(CAE 503)]
Lecture: 2 **Lab:** 2 **Credits:** 4

CAE 523
Statistical Analysis of Engineering Data
Descriptive statistics and graphs, probability distribution, random sampling, independence, significance tests, design of experiments, regression, time series analysis, statistical process control, and introduction to multivariate analysis.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 524
Building Enclosure Design
Design of building exteriors, including the control of heat flow, air and moisture penetration, building movements, and deterioration. Study of the principle of rain screen walls and of energy conserving designs. Analytical techniques and building codes are discussed through case studies and design projects.
Prerequisite(s): [(CAE 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 525
Advanced Steel and Composite Structures
Torsion and web openings. Behavior and design of rigid and semi rigid beam-to-column connections and base plates. Inelastic behavior of steel and composite members and systems under severe cyclic loading. Design of steel-concrete composite and hybrid systems. P-delta effect and design considerations for system stability. Design of special and ordinary moment-resisting frames. Design of concentrically and eccentrically braced frames. Design of bracing for stability. Plate girders. Fatigue and fracture.
Prerequisite(s): [(CAE 431*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 526
Energy Conservation Design in Buildings
Identification of the optimal energy performance achievable with various types of buildings and service systems. Reduction of infiltration. Control systems and strategies to achieve optimal energy performance. Effective utilization of daylight, heat pumps, passive and active solar heaters, heat storage and heat pipes in new and old buildings.
Prerequisite(s): [(CAE 331) OR (CAE 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 527
Control of Building Environmental Systems
Introduction to automatic control systems. Control issues related to energy conservation, indoor air quality and thermal comfort in buildings. Classification of HVAC control systems. Control systems hardware: selection & sizing of sensors, actuators & controllers. Practical HVAC control systems; elementary local loop and complete control systems. Case studies. Computer applications.
Prerequisite(s): [(CAE 513) OR (CAE 531)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 528
Building Electrical Systems Design
Study of the analysis and design of electrical systems in buildings utilizing the National Electric Code. Topics include AC, DC, single phase and three-phase circuits, transients, branch circuits, panel boards, system sizing, fault calculations and overcurrent protection design. Also studies the design and specification of emergency power backup and alternative power systems. Previous coursework in electrical circuits is required. Permission from the instructor is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 529
Dynamics of Structures
Fundamentals of free, forced, and transient undamped and viscously damped vibration of single and multi-degree of freedom structures. Time, frequency, and approximate methods of analysis. Application of numerical methods in time and frequency domain. Response spectra, modes, coupling and modal space. Response history and response spectrum analyses and an introduction to earthquake engineering.
Prerequisite(s): [(CAE 411)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 530
Finite Element Method of Analysis
Advanced and special topics in finite element analysis such as finite element-boundary element method, plates, and shell analysis using finite elements.
Prerequisite(s): [(CAE 411)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 532
Analysis of Plates and Shells
Exact and approximate stress analysis of elastic, isotropic plates of various shapes acted upon by forces in their plane, as well as transverse forces. Stability of plates with various edge conditions, orthotropic plates, elastically supported plates and simple cylinders. Approximate methods such as finite differences, finite elements and the methods of Ritz and Galerkin.
Prerequisite(s): [(CAE 503)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 533
Theory and Analysis of Thin Shells
Differential geometry of surfaces. Elastic theory of general shells with nonorthogonal curvilinear coordinates. Specialization to cylindrical shells, shells of revolution and translational shells. Exact and approximate solutions applied to the bending membrane theories of thin shells. Approximate methods including finite differences, finite elements and methods associated with Ritz, Galerkin, Puchler and Gaeckler.
Prerequisite(s): [(CAE 503)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 534
Computational Techniques in Finite Element Analysis
Survey of numerical methods as applied to FEM software. Database management, equation solvers, eigen value routines and schemes for direct integration (both implicit/explicit), all as employed in the development of a finite element program. Topics covered also include band and front minimizers, static and dynamic substructuring via super elements and sensitivity studies. Same as MAE 538.
Prerequisite(s): [(CAE 530*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 535
Nonlinear Finite Element Analysis
FEM as applied to nonlinear problems. Contact problems, the mechanics of large deformation, full and updated Lagrange formulations, review of plasticity, solution algorithms, Eulerian approaches, application to FEM to limit analysis. Same as MAE 539.
Prerequisite(s): [(CAE 442) OR (CAE 514) OR (MMAE 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 537
Homeland Security Concerns in Building Designs
Review of blast effects produced by solid phase weapons and their effects on structures and people. Estimation of the risk of a terrorist attack and the corresponding threat. Review of simplified methods for the analysis and design of structures to meet homeland security concerns and procedures to minimize casualties. Analysis of post event fires and how to prevent them. Review of security measures to minimize the effects of blast on buildings and people.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 539
Introduction to Geographic Information Systems
Geographic information system (GIS) technology allows users to combine tabular information with maps, creating powerful spatial databases which display and query information in new ways. This course will teach general GIS and GPS skills and concepts, useful to students and practitioners in a variety of disciplines. Students will complete a final GIS project relevant to their field of study. This hands-on class will use ESRI's ArcView and Spatial Analyst products, as well as Trimble GeoExplorer GPS units.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 540
Asphalt and Concrete Mix Design
Types of asphalt and physical properties of asphalt. Types of mixes: dense graded, open graded, base courses, and maintenance mixes. Types of pavement structures and hot mix asphalt placement. Aggregate physical properties, tests, and blending. Maintenance and rehabilitation materials. Mixture design procedures, including Marshall and Hveem procedures, and weight-volume relationships. Evaluation of mixture properties, engineering property's importance to performance, resilient modulus, fatigue, and creep testing, and thermal cracking properties. Laboratory included.
Lecture: 2 **Lab:** 3 **Credits:** 3

CAE 541
Pavement Evaluation and Management
Pavement management systems (PMS) concepts, network definition, condition survey, pavement condition index (PCI), non-destructive deflection testing (NDT), measurement of roughness and skid resistance, micropaver PMS, PMS implementation, project and network-level management, maintenance alternatives, development of annual and long-range work plans.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 543
Demand Models for Urban Transportation
Fundamental theory of supply and demand, transportation economics, network equilibrium, land use and transportation equilibrium. Demand models: trip generation, geographical distribution, mode split, route assignment, the direct-demand model and disaggregate-behavioral-demand models. Special properties of models. Relationships among models.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 544
Urban Transportation Planning
Exploration of the goals of urban transportation. Program planning in relating transportation technology to social, economic, and environmental systems. Systems analysis in forecasting urban land use and travel demand and evaluating alternatives in transportation planning to reach a balance between demand and supply.
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 545
Traffic Operations and Flow Theory
Studies of space and time distribution of speed and other traffic characteristics in the transportation network. Macro, micro, and mesoscopic traffic flow theories. Simulation in traffic networks. Application of flow theories to traffic control and operations.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 546
Public Transportation Systems
Operational and economic characteristics of urban systems. Transit planning process: demand for transit, transit routing, transit scheduling, network design. Improvements of existing systems and exploration of new technologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 547
Advanced Traffic Engineering
Data collection, statistical analysis, and interpretation of traffic information. Advanced traffic engineering topics such as signaling, street-and-highway capacity analysis, and highway safety research.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 548
Transportation Systems Management
Transportation as a system. Problems of traffic congestion, land use/transportation intersection; intersection control; freeway and arterial incident management; safety considerations; evaluation of strategies; case studies.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 549
Transportation Economics, Development and Policy
Application of managerial, micro- and macroeconomic concepts to transportation systems. Investment and impact analysis. Transport policy as it relates to social, economic and environmental issues. Legislative actions affecting transport issues.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 551
Prestressed Concrete
Theory and design of prestressed concrete members and structure. Applications to both simple and continuous girder and frames subjected to stationary or moving loads. Prestressed cylindrical shells.
Prerequisite(s): [(CAE 432*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 553
Measurement and Instrumentation in Architectural Engineering
Hands-on experience with energy and indoor air quality measurements in buildings including experimental design, data analysis, and experimental statistics. Measurements and techniques covered include: thermal performance (e.g., thermal conductivity and resistance, heat flux, and temperature); fluid flows and HVAC characteristics (e.g., velocity, pressure, and airflow); energy performance (e.g., current, voltage, and power draw); whole building diagnostics (e.g., blower door and duct blaster); and indoor air quality (e.g., tracer gas techniques for air exchange, particle measurements, and gas measurements). Course combines lectures and field measurements in buildings on campus.
Prerequisite(s): [(CAE 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 555
Transportation Systems Evaluation
Concepts and principles of transportation economic analysis, transportation costs and benefits, user and nonuser consequences, needs studies, finance and taxation, methods for evaluation of plans and projects, cost-efficiency, cost-effectiveness, environmental impact assessment, and economic development assessment.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 556
Net Zero Energy Home Design Competition I
This is a project-based course in which students will compete in the Department of Energy's annual Race to Zero home design competition. The goal is for an interdisciplinary team of students to design and provide full documentation for a home that meets the Department of Energy's Zero Energy Ready Home Requirements. Teams are expected to effectively and affordably integrate principles of building science, construction engineering and management, economic analysis, and architectural design in an integrated design process. Teams will be required to submit full sets of plans, drawings, renderings, construction details, and analyses for energy efficiency, costs, and affordability. The competition is designed to provide the next generation of architects, engineers, construction managers, and entrepreneurs with skills and experience to start careers in clean energy and generate creative solutions to real-world problems. CAE 556 is the first course in a two-course series. CAE 556 focuses on aspects of the building design. Priority is given to Architectural Engineering and Architecture majors.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 557
Net Zero Energy Home Design Competition II
This is a project-based course in which students will compete in the Department of Energy's annual Race to Zero home design competition. The goal is for an interdisciplinary team of students to design and provide full documentation for a home that meets the Department of Energy's Zero Energy Ready Home Requirements. Teams are expected to effectively and affordably integrate principles of building science, construction engineering and management, economic analysis, and architectural design in an integrated design process. Teams will be required to submit full sets of plans, drawings, renderings, construction details, and analyses for energy efficiency, costs, and affordability. The competition is designed to provide the next generation of architects, engineers, construction managers, and entrepreneurs with skills and experience to start careers in clean energy and generate creative solutions to real-world problems. CAE 557 is the second course of a two-course series. CAE 557 focuses on the final project reporting and submission. Priority is given to Architectural Engineering and Architecture majors.
Prerequisite(s): [(CAE 556 with min. grade of C)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 560
Plastic Methods
Fundamental concepts of plasticity in the design of steel structures. Principle of plastic hinges. Upper and lower-bound theorems. Alternating plasticity and incremental collapse. Analysis and design of single story and multi-story framed structures.
Prerequisite(s): [(CAE 431* and CAE 503*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 561
Structural Reliability and Probabilistic Bases of Design
Fundamentals of probability theory and stochastic processes; statistical analysis of engineering data; probabilistic modeling of structural loads and material properties. Reliability analysis and design of structure, reliability-based design criteria. Evaluation of existing design codes. Safety analysis of structures under fatigue loads. Fault and event tree analysis.
Prerequisite(s): [(CAE 307)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 562
Engineering Behavior of Soil
Soil mineralogy and soil fabric, soil-water electrolyte system, dispersive clay, stress and strain analyses, elastic equilibrium in soil masses, plastic equilibrium in soil masses, in situ and laboratory stress paths, shear strength of sands and clays, thermal properties of soils, critical state soil mechanics principles, nonlinear pseudo elastic and elastoplastic constitutive models.
Prerequisite(s): [(CAE 323)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 563
Advanced Soil Mechanics Laboratory
Advanced aspects of soil property measurement with application to design and analysis, system characteristics on soil sediment, pinhole test for identifying dispersive clays, consolidation, triaxial compression and triaxial extension with porewater measurement, cyclic triaxial test, permeability with back pressure, determination of critical void ratio.
Prerequisite(s): [(CAE 323)]AND[(CAE 562*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 1 **Lab:** 3 **Credits:** 1

CAE 564
Design of Foundations, Embankments and Earth Structures
Consolidation phenomena, derivation of bearing capacity equations, beams and slabs on soils, piles and pile groups, compaction, earth pressure theories and pressure in embankment, slope stability analyses, retaining structures, embankment design, soil structure interaction during excavation, design of anchors for landslide stabilization and retaining structures and instrumentation.
Prerequisite(s): [(CAE 323)]AND[(CAE 457 with min. grade of C)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 565
Rock Mechanics and Tunneling
Rock classification for engineering purposes, mechanical behavior of rocks, in situ stresses in rock, stresses around underground openings, rock slope engineering, design of underground structures, design of deep support excavation and tunnels, primary and secondary linings of tunnels, mined shafts, instrumentation.
Prerequisite(s): [(CAE 457)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 566
Earthquake Engineering and Soil Dynamics
Earthquakes and their intensity, influence of group motion, review of I-DOF and M-DOF systems, wave propagation theories, vibration due to blast and shock waves, design earthquake motion, dynamic properties of soils, soil liquefaction, bearing capacity during earthquakes and design of machine foundations, isolation of foundations, pile foundation, and dynamic analysis, earth pressure during earthquakes on retaining structures and embankment.
Prerequisite(s): [(CAE 323)]AND[(CAE 420)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 568
Transportation Asset Management
Processes and techniques for managing the preservation and expansion of highway transportation facilities such as pavements, bridges, and traffic control and safety hardware; system usage concerning mobility, safety and security, energy consumption, and vehicle emissions; and economic development impacts. Five component management systems are first examined: pavements, bridges, traffic control and safety hardware, roadway maintenance, safety, and congestion. Finally, the methodology for overall transportation asset management is discussed. The primary emphasis is on data collection, database management, performance modeling, needs assessment, project evaluation, project selection, program development strategies, risk and uncertainty modeling, and institutional issues.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 570
Legal Issues in Civil Engineering
This course introduces students to the legal aspects of engineering and construction, contract documents, and contract clauses. Upon completion of this course, students will be able to do the following: (1) identify the elements of contract formation; (2) interpret contract clauses; (3) explain the rights and duties of the parties involved in design and construction; and (4) evaluate changes and their root causes. Students will also be able to objectively identify and analyze legal liabilities and the expected professional standard of architects, engineers, and contractors.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 571
Lean Construction and Control
This course introduces students to lean principles and the lean project delivery system (LPDS) applied to the construction industry. Lean construction and lean project delivery embrace concepts and techniques originally conceived in the automobile manufacturing industry and adopted by the construction industry. In the manufacturing sector, lean production has revolutionized product manufacturing, resulting in significant gains in plant productivity, reliability, and reductions in defects. Specific concepts that will be covered in this course include Plan-Do-Check-Act continuous improvement, A3 reporting, value stream mapping, pull systems and pull planning, kanban, 5S, standardization, and the Choosing by Advantages Decisionmaking System.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 572
Construction Cost Accounting and Control
Review of basic accounting principles and techniques--purchasing, accounts payable, invoicing, accounts receivable, general ledger, payrolls and indirect costs. Job costing and budgeting. Recording and reporting procedures in construction projects--invoices, subcontractor applications for payment, labor time cards, unit completion reports, change orders. Cost coding systems for construction activities. Variance reporting procedures. Project closeout. Class exercise using computer program.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 573
Construction Management with Building Information Modeling
Fundamentals and practical use of information technologies in the construction industry; basic concepts of building information modeling (BIM); review of software and technology available for BIM; practical use of BIM including design and clash detection; impact of BIM on construction management functions; construction scheduling and sequencing using BIM; cost estimating using BIM; facility management with BIM; integrated approach to navigate BIM as a multi-disciplinary design, analysis, construction, and facility management technology; class exercise to create a BIM model and to use it in scheduling, sequencing, cost estimating, management, and simulation of a construction project.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 574
Economic Decision Analysis in Civil Engineering
Basic economic concepts including interest calculations, economic comparison of alternatives, replacement decisions, depreciation and depletion, tax considerations, and sensitivity analysis. Evaluation of public projects, the effect of inflation, decision making under risk and/or uncertainty, economic decision models. Case studies from the construction industry.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 575
Systems Analysis in Civil Engineering
Management and system concepts, linear programming, graphical methods, Simplex, two-phase Simplex, the transportation problem, the assignment problem, integer programming, and sensitivity analysis. System modeling by activity networks; maximal-low flow, longest-path and shortest-path analyses, flow graphs, decision-tree analysis, stochastic-network modeling, queuing systems, and analysis of inventory systems. Case studies from the construction industry.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 577
Construction Equipment Management
Factors affecting the selection of construction equipment. Descriptions, operating methods, production rates, unit costs related to excavating equipment. Power shovels, draglines, clam shells, and trenching machines. Engineering fundamentals. Moving construction equipment, including trucks, wagons, scrapers, dozers, soil-stabilization and compaction equipment. Belt conveyors, compaction and drilling equipment, pile driving equipment, pumps and crushers.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 578
Construction Claims Management
This course provides a basic explanation of construction contract claims by types such as delays, acceleration, and scope issues, the underlying legal theories of the contract construction and claims, elements required for each claims type defenses to the claim, prophylactic claims measures. The claims process within the contract and extra-contractual basis's for claims are examined. Resolution of claims by ADR techniques and the formal litigation process are explained. AIA, AGC, and federal claims provisions are described. In addition to construction contract claims other types of claims associated with construction projects are covered such as Surety bond claims and various insurance claims (CGL, Builder's Risk, workers comp, etc)
Prerequisite(s): [(CAE 473)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 579
Real Estate Fundamentals for Engineers and Architects
The objective of this course is to introduce civil engineering students to the real estate process. Students will learn techniques and methodologies for evaluating real estate investment opportunities using engineering economic analysis principles. Students will use Time Value of Money analysis for evaluating real estate transactions, including how to carry out calculations using formulas, financial calculators, and spreadsheets. This course will help civil engineering students learn financial skills that can be applied to professional and personal investment decisions.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 580
Intelligent Transportation Systems
The concept of intelligent transportation systems (ITS) involves the use of rapidly emerging information and communication technologies in mitigating congestion and attendant problems. A substantial amount of research and development activities have taken place over the last few decades. This course will provide an introduction to the various aspects of ITS and will focus on ITS planning, technology, big data analysis, and evaluation. In addition, such topics as deployment, financing, and management are also discussed. The course will include guest lectures and possibly field visits.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 581
Algorithms in Transportation
Modeling and analysis of transportation network problems through the design, analysis, and implementation of algorithms. Emphasis on the use of quantitative and qualitative methods of operations research to model system performance. Covers fundamental data structures, complexity analysis, memory management, recursive programs, application of graph theory, and network analysis to transportation problems, analytical formulations, and solution algorithms for origin-destination estimation, static and dynamic traffic assignments, and transportation resource allocation.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 582
Structural Wind and Earthquake Engineering
Introduction to nature of wind, aerodynamic wind-loading and design. Strong ground motion phenomenon. Investigation of the response of structures to dynamic and pseudo dynamic wind, earthquake, shock waves and other deterministic and probabilistic loadings. Design criteria for buildings and nuclear power stations, special topics in lifeline earthquake engineering.
Prerequisite(s): [(CAE 529)]
Lecture: 4 **Lab:** 0 **Credits:** 4

CAE 583
Performance-Based Structural and Seismic Design of Buildings and Bridges
This course covers performance-based structural and seismic design (PBSSD) for buildings and bridges. The course will begin with brief reviewing and critical discussion on conventional code-based seismic design followed by the development of the concept and applicability of this new alternative and advanced PBSSD. Computer methods in linear dynamic, nonlinear static, and dynamic analyses will be surveyed and discussed as primary tools in PBSSD. Ample case studies from real-world projects are carried out throughout the course. These case studies include the PBSSD of special structures, tall buildings, and those that building code-based design is not applicable.
Prerequisite(s): [(CAE 529)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 584
Stormwater Management
Basic principles of storm water management; hydrology and hydraulics of excess water; excess water management and design; sewer system design and management, storm water detention systems; flood plain system design; risk based design of drainage systems; practical and case study problems.
Prerequisite(s): [(CAE 301)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 586
Seismic Design of Building and Bridge Structures
The course covers six topics, as listed in the course outline, on seismic design of steel and R/C building structures and bridges. In addition to offer fundamentals and experiences in seismic design through design examples, it is also assumed that structural engineers who are preparing for their Structural Engineer License Exam might find extremely helpful.
Prerequisite(s): [(CAE 431 and CAE 432)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 589
Groundwater Hydrology and Sampling
Groundwater geology and flow, response of ideal aquifer to pumping. Chemical properties and principles including source of contamination and estimation of saturated hydraulic conductivity. Principles of exploration and sampling, methods of subsurface explorations, groundwater observation techniques. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 590
Geotechnical Landfill Design and Maintenance
Regulatory and legal issues, site selection and assessment, geotechnical-subsurface investigation, clay mineralogy and clay-water-electrolyte system, linear and leachate-control-systems design, stability of landfill slopes, cover design, construction and operation, final use and remediation design.
Prerequisite(s): [(CAE 323)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CAE 591
Research and Thesis for M.S. Degree
Research and Thesis for M.S. Degree.
Credit: Variable

CAE 593
Civil Engineering Seminar
Reports on current research. Graduate students are expected to register and attend.
Lecture: 0 **Lab:** 0 **Credits:** 0

CAE 594
Research Problems
Credit: Variable

CAE 597
Special Problems
Graduate course work in the problem subject matter. Subject matter will vary with the interests and background of students and instructor. Design or research problems may be assigned from the areas of architectural, construction, geotechnical, geoenvironmental, structural, or transportation engineering.
Credit: Variable

CAE 598
Special Topics
A special topic in civil or architectural engineering at the graduate level.
Credit: Variable

CAE 599
Graduate Workshop
Graduate workshop.
Lecture: 0 **Lab:** 0 **Credits:** 0

CAE 691
Research and Thesis for Ph.D. Degree
Research and Thesis for Ph.D. degree.
Credit: Variable

CAE 724
Introduction to Acoustics
This short course provides a brief introduction to the fundamentals of acoustics and the application to product noise prediction and reduction. The first part focuses on fundamentals of acoustics and noise generation. The second part of the course focuses on applied noise control.
Lecture: 2 **Lab:** 0 **Credits:** 2

ENVE 501
Environmental Chemistry
Chemical processes in environmental systems with an emphasis on equilibrium conditions in aquatic systems. Processes examined include acid-base, dissolution precipitation, air-water exchange, and oxidation-reduction reactions. Methods presented for describing chemical speciation include analytical and graphical techniques as well as computer models.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 506
Chemodynamics
Processes that determine the fate and transport of contaminants in the environment. Upon successful completion of this course, students should be able to formulate creative, comprehensive solutions to transport problems, critically evaluate proposed solutions to transport problems, and acquire and integrate new information to build on these fundamentals.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 513
Biotechnological Processes in Environmental Engineering
Fundamentals and applications of biological mixed culture processes for air, water, wastewater, and hazardous waste treatment. Topics include biochemical reactions, stoichometry, enzyme and microbial kinetics, detoxification of toxic chemicals, and suspended growth and attached growth treatment processes. The processes discussed include activated sludge process and its modifications, biofilm processes including trickling filters and biofilters, nitrogen and phosphorous removal processes, sludge treatment processes including mesophilic and thermophilic systems, and natural systems including wetlands and lagoons.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 528
Modeling of Environmental Systems
To introduce students to mathematical modeling as a basic tool for problem solving in engineering and research. Environmental problems will be used as examples to illustrate the procedures of model development, solution techniques, and computer programming. These models will then be used to demonstrate the application of the models including simulation, parameter estimation, and experimental design. The goal is to show that mathematical modeling is not only a useful tool but also an integral part of process engineering.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 542
Physiochemical Processes in Environmental Engineering
Fundamentals and applications of physicochemical processes used in air, water, wastewater, and hazardous waste treatment systems. Topics include reaction kinetics and reactors, particle characterization, coagulation and flocculation, sedimentation, filtration, membrane separation, adsorption, and absorption.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 551
Industrial Waste Treatment
Industrial waste sources and characteristics, significance of industrial waste as environmental pollutants; applications of standard and special treatment processes including physical, chemical, and biological systems.
Prerequisite(s): [(ENVE 513*) OR (ENVE 542*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 561
Design of Environmental Engineering Processes
Design of water and wastewater treatment systems. System economics and optimal design principles.
Prerequisite(s): [(ENVE 513*) OR (ENVE 542*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 570
Air Pollution Meteorology
Physical processes associated with the dispersion of windborne materials from industrial and other sources. Atmospheric motion including turbulence and diffusion, mathematical models, and environmental impact assessment.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 576
Indoor Air Pollution
Indoor air pollution sources, indoor pollutant levels, monitoring instruments and designs, and indoor pollution control strategies; source control, control equipment and ventilation; energy conservation and indoor air pollution; exposure studies and population time budgets; effects of indoor air population; risk analysis; models for predicting source emission rates and their impact on indoor air environments.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 577
Design of Air Pollution Control Devices
Principles and modern practices employed in the design of engineering systems for the removal of pollutants. Design of control devices based on physical and chemical characteristics of polluted gas streams.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 578
Physical and Chemical Processes for Industrial Gas Cleaning
Application of physical and chemical processes in the design of air treatment systems; fundamentals of standard and special treatment processes.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 580
Hazardous Waste Engineering
Sources and characteristics of hazardous wastes, legal aspects of hazardous waste management, significance of hazardous wastes as air, water, and soil pollutants. Principles and applications of conventional and specialized hazardous waste control technologies.
Prerequisite(s): [(ENVE 506*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

ENVE 590
Environmental Engineering Seminar
Current topics in environmental engineering featuring presentations by practitioners from a range of institutions such as academia, industry, consulting, research laboratories, or government.
Lecture: 0 **Lab:** 0 **Credits:** 0

ENVE 591
Research and Thesis M.S.
Graduate research.
Credit: Variable

ENVE 597
Special Problems
Independent study and project. (Variable credit)
Credit: Variable

ENVE 691
Research and Thesis Ph.D.
Graduate research.
Credit: Variable

Master of Engineering in Architectural Engineering

These master of engineering programs are course-only, professionally oriented degree programs that permit a concentration in preparation for engineering practice. Admission requirements to these programs are the same as those for the master of science program. Candidates in these programs must complete a minimum of 32 credit hours, up to three of which may be a special project course—CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the master of engineering program with prior adviser approval. No thesis or comprehensive examination is required for completion of the degree.

The Master of Engineering in Architectural Engineering program is oriented toward students who need to develop more knowledge about buildings. Students are expected to have educational backgrounds in architectural engineering, mechanical engineering, structural engineering, architecture, or other relevant disciplines. The program covers the three basic aspects of architectural engineering: building science, structures, and construction management.

Curriculum

This program involves four core courses, four or five elective courses from one field of concentration, and two courses from any relevant field of concentration, general background courses, or graduate courses offered by the College of Architecture.

Core Courses			(12)
CAE 513	Building Science		3
CAE 574	Economic Decision Analysis in Civil Engineering		3
Select a minimum of two courses from the following:			6
CAE 502	Acoustics and Lighting	3	
CAE 521	Building Illumination Design	3	
CAE 524	Building Enclosure Design	3	
CAE 553	Measurement and Instrumentation in Architectural Engineering	3	
ENVE 576	Indoor Air Pollution	3	
Specialization Electives			(12-15)
Select 12-15 credit hours [1]			12-15
General Electives			(6-9)
Select 6-9 credit hours from the following courses: [2]			6-9
CAE 430	Probability Concepts in Civil Engineering Design	3	
CAE 523	Statistical Analysis of Engineering Data	3	
CAE 575	Systems Analysis in Civil Engineering	3	
CAE 597	Special Problems	Credit Variable	
CHE 543	Energy, Environment, and Economics	3	
MMAE 515	Engineering Acoustics	3	

Minimum degree credits required: 32

1. Specializations in Building Systems, Construction Management, or Structures require 12-15 credit hours in the area of specialization. Please see the Specializations tab on this page.
2. Other courses are allowed but are subject to adviser approval.

Architectural Engineering Specializations

Students must complete 12-15 credit hours from one area of specialization (Building Systems, Construction Management, or Structures).

Building Systems

Select a minimum of four to five courses from the following:			12-15
ARCH 551	Design of Energy-Efficient Buildings I	3	
ARCH 552	Design of Energy-Efficient Buildings II	3	
CAE 461	Plumbing and Fire Protection Design	3	
CAE 464	HVAC Systems Design	3	
CAE 502	Acoustics and Lighting	3	
CAE 506	Building Envelope Rehabilitation	3	
CAE 510	Dynamics of Fire	3	
CAE 511	Fire Protection of Buildings	3	
CAE 512	Computer Modeling of Fire	3	
CAE 521	Building Illumination Design	3	
CAE 524	Building Enclosure Design	3	
CAE 526	Energy Conservation Design in Buildings	3	
CAE 527	Control of Building Environmental Systems	3	
CAE 528	Building Electrical Systems Design	3	
CAE 553	Measurement and Instrumentation in Architectural Engineering	3	
ENVE 576	Indoor Air Pollution	3	
MMAE 517	Computational Fluid Dynamics	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 526	Heat Transfer: Conduction	3	
MMAE 527	Heat Transfer: Convection and Radiation	3	
Total Credit Hours			12-15

Construction Management

Select a minimum of four to five courses from the following:			12-15
ARCH 560	Integrated Building Delivery Practice/BIM	3	
CAE 470	Construction Methods and Cost Estimating	3	
CAE 471	Construction Planning and Scheduling	3	
CAE 472	Construction Site Operation	3	
CAE 473	Construction Contract Administration	3	
CAE 486	Soil and Site Improvement	3	
CAE 570	Legal Issues in Civil Engineering	3	
CAE 571	Lean Construction and Control	3	
CAE 572	Construction Cost Accounting and Control	3	
CAE 573	Construction Management with Building Information Modeling	3	
CAE 575	Systems Analysis in Civil Engineering	3	
CAE 577	Construction Equipment Management	3	
CAE 578	Construction Claims Management	3	
CAE 579	Real Estate Fundamentals for Engineers and Architects	3	
Total Credit Hours			12-15

Structures

Select a minimum of four to five courses from the following:			12-15
CAE 410	Introduction to Wind and Earthquake Engineering	3	
CAE 435	Experimental Analysis of Structures	3	
CAE 436	Design of Masonry and Timber Structures	3	
CAE 457	Geotechnical Foundation Design	3	
CAE 503	Advanced Structural Analysis	3	
CAE 504	Seismic Retrofit and Earthquake Hazard Reduction	4	
CAE 518	Advanced Reinforced Concrete	3	
CAE 520	Buckling of Structures	4	
CAE 522	Structural Model Analysis	4	
CAE 525	Advanced Steel and Composite Structures	4	
CAE 530	Finite Element Method of Analysis	3	
CAE 532	Analysis of Plates and Shells	4	
CAE 533	Theory and Analysis of Thin Shells	3	
CAE 534	Computational Techniques in Finite Element Analysis	3	
CAE 537	Homeland Security Concerns in Building Designs	3	
CAE 551	Prestressed Concrete	3	
CAE 560	Plastic Methods	4	
CAE 561	Structural Reliability and Probabilistic Bases of Design	3	
CAE 564	Design of Foundations, Embankments and Earth Structures	4	
CAE 582	Structural Wind and Earthquake Engineering	4	
Total Credit Hours			12-15

Master of Engineering in Construction Engineering and Management

These master of engineering programs are course-only, professionally oriented degree programs that permit a concentration in preparation for engineering practice. Admission requirements to these programs are the same as those for the master of science program. Candidates in these programs must complete a minimum of 32 credit hours, up to three of which may be a special project course—CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the master of engineering program with prior adviser approval. No thesis or comprehensive examination is required for completion of the degree.

The Master of Engineering in Construction Engineering and Management provides students with the knowledge and background that is essential to making decisions at site, company, industrial, and sector levels. Students learn how to plan and schedule projects, estimate and control costs, make economic decisions, administer contracts, organize construction sites, manage construction equipment, analyze productivity, optimize construction activities, plan and manage real estate developments, and address legal problems.

Curriculum

Core Courses		(12)
CAE 570	Legal Issues in Civil Engineering	3
CAE 571	Lean Construction and Control	3
CAE 574	Economic Decision Analysis in Civil Engineering	3
CAE 577	Construction Equipment Management	3
Elective Courses		(20)
Select 20 credit hours		20
Total Credit Hours		32

Master of Engineering in Environmental Engineering

These master of engineering programs are course-only, professionally oriented degree programs that permit a concentration in preparation for engineering practice. Admission requirements to these programs are the same as those for the master of science program. Candidates in these programs must complete a minimum of 32 credit hours, up to three of which may be a special project course—CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the master of engineering program with prior adviser approval. No thesis or comprehensive examination is required for completion of the degree.

Curriculum

All environmental engineering students must take five core courses. The remaining credit hours in the program of study should be selected, in consultation with the student's adviser, to meet the student's professional goals. Up to 9 credit hours in courses numbered 400-499 may be selected in some cases to overcome deficiencies or broaden the student's background.

Core Courses		(15)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
General Electives		(17)
Select 17 credit hours		17
Total Credit Hours		32

Master of Engineering in Geotechnical Engineering

These master of engineering programs are course-only, professionally oriented degree programs that permit a concentration in preparation for engineering practice. Admission requirements to these programs are the same as those for the master of science program. Candidates in these programs must complete a minimum of 32 credit hours, up to three of which may be a special project course—CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the master of engineering program with prior adviser approval. No thesis or comprehensive examination is required for completion of the degree.

The geotechnical engineering program provides background knowledge and training to prepare students to analyze, design, and construct structures, and to provide solutions to problems in geotechnical engineering and environmental geotechnics. The subjects include engineering behavior of soil and rock, geomechanics, foundations, earth support structures, dams, tunnels, slope stability, geotechnical earthquake engineering and soil dynamics, site improvement, geosynthetics, groundwater, pollutant transport, chemical behavior of soil, and waste disposal facilities. Laboratory experiments and computer analyses/modeling are incorporated.

Curriculum

Required Courses		(16)
CAE 562	Engineering Behavior of Soil	4
CAE 564	Design of Foundations, Embankments and Earth Structures	4
CAE 565	Rock Mechanics and Tunneling	4
CAE 566	Earthquake Engineering and Soil Dynamics	4
General Electives		(16)
Select 16 credit hours		16
Total Credit Hours		32

Master of Engineering in Structural Engineering

These master of engineering programs are course-only, professionally oriented degree programs that permit a concentration in preparation for engineering practice. Admission requirements to these programs are the same as those for the master of science program. Candidates in these programs must complete a minimum of 32 credit hours, up to three of which may be a special project course—CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the master of engineering program with prior adviser approval. No thesis or comprehensive examination is required for completion of the degree.

The Master of Engineering in Structural Engineering provides students with the knowledge needed to design the built environment. Students learn how buildings and bridges may be designed to resist the forces imposed upon them by external loads, gravity, wind, and earthquakes. Up-to-date computer-aided design techniques and the latest national building codes dealing with steel, reinforced concrete, pre-stressed concrete, and masonry structures are treated.

Curriculum

Core Courses		(13)
MMAE 501	Engineering Analysis I	3
or CAE 514	Mathematical Methods for Structural Engineering	
CAE 503	Advanced Structural Analysis	3
CAE 518	Advanced Reinforced Concrete	3
CAE 525	Advanced Steel and Composite Structures	4
General Electives		(19)
Select 19 credit hours		19
Total Credit Hours		32

Master of Engineering in Transportation Engineering

These master of engineering programs are course-only, professionally oriented degree programs that permit a concentration in preparation for engineering practice. Admission requirements to these programs are the same as those for the master of science program. Candidates in these programs must complete a minimum of 32 credit hours, up to three of which may be a special project course—CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the master of engineering program with prior adviser approval. No thesis or comprehensive examination is required for completion of the degree.

With a Master of Engineering in Transportation Engineering degree, a student will be a qualified transportation planner, traffic engineer, and traffic safety engineer. Additionally, the student will be trained to understand and evaluate the socioeconomic impacts of transportation and infrastructure engineering projects.

Curriculum

Core Courses			(12-13)
Select a minimum of four courses from the following with adviser consent:			12-13
CAE 523	Statistical Analysis of Engineering Data	3	
CAE 543	Demand Models for Urban Transportation	3	
CAE 544	Urban Transportation Planning	4	
CAE 546	Public Transportation Systems	3	
CAE 548	Transportation Systems Management	3	
CAE 555	Transportation Systems Evaluation	3	
CAE 575	Systems Analysis in Civil Engineering	3	
MATH 525	Statistical Models and Methods	3	
Project Course			(1-3)
CAE 597	Special Problems		1-3
General Electives			(18)
Select 18 credit hours from the following:			18
CAE 416	Facility Design of Transportation Systems	3	
CAE 417	Railroad Engineering and Design	3	
CAE 419	Introduction to Transportation Engineering and Design	3	
CAE 430	Probability Concepts in Civil Engineering Design	3	
CAE 508	Advanced Bridge Engineering	3	

CAE 539	Introduction to Geographic Information Systems	3
CAE 541	Pavement Evaluation and Management	3
CAE 545	Traffic Operations and Flow Theory	3
CAE 547	Advanced Traffic Engineering	3
CAE 549	Transportation Economics, Development and Policy	3
CAE 568	Transportation Asset Management	3
CAE 574	Economic Decision Analysis in Civil Engineering	3
CAE 580	Intelligent Transportation Systems	3
CAE 581	Algorithms in Transportation	3
MATH 522	Mathematical Modeling	3
MATH 542	Stochastic Processes	3
MATH 563	Mathematical Statistics	3
MATH 564	Applied Statistics	3
MATH 565	Monte Carlo Methods in Finance	3
MATH 571	Data Preparation and Analysis	3
MATH 574	Bayesian Computational Statistics	3

Minimum degree credits required: 32

Master of Public Works (Infrastructure Engineering and Management)

The Master of Engineering in Public Works (M.P.W.) degree is the most widely recognized educational credential for professionals engaged in public works and infrastructure engineering and management. The M.P.W. program consists of four core courses, four engineering electives (in construction engineering and management, geotechnical engineering, structural engineering, or transportation engineering), two public administration electives (in administration process or policy planning), and one CAE 597 special problems course. The elective courses should be selected in consultation with the student's adviser. This program is offered in cooperation with the university's Master of Public Administration program.

Curriculum

Core Courses		(12)
CAE 574	Economic Decision Analysis in Civil Engineering	3
CAE 575	Systems Analysis in Civil Engineering	3
PA 501	Essentials for Public Management in a Complex Society: Processes, Structures, and Values	3
PA 551	Public Infrastructure Management	3
Electives		(18-19)
Select 18-19 credit hours (see recommended courses below)		18-19
CAE Special Problems Course		(1-3)
CAE 597	Special Problems	1-3

Minimum degree credits required: 32

Recommended Elective Coursework by Subject

Construction Management

CAE 470	Construction Methods and Cost Estimating	3
CAE 471	Construction Planning and Scheduling	3
CAE 472	Construction Site Operation	3
CAE 473	Construction Contract Administration	3

Geotechnical Engineering

CAE 482	Hydraulic Design of Open Channel Systems	3
CAE 486	Soil and Site Improvement	3
CAE 562	Engineering Behavior of Soil	4
CAE 564	Design of Foundations, Embankments and Earth Structures	4

CAE 565	Rock Mechanics and Tunneling	4
CAE 566	Earthquake Engineering and Soil Dynamics	4
CAE 589	Groundwater Hydrology and Sampling	3
CAE 590	Geotechnical Landfill Design and Maintenance	3
ENVE 404	Water and Wastewater Engineering	3
ENVE 551	Industrial Waste Treatment	3

Public Administration - Administration Process

PA 502	Leading and Managing Knowledge-Intensive Organizations	3
PA 503	Administration Law	3
PA 522	Effective Management of Human Resources in Environments of Scarce Resources	3
PA 532	Managing Public Financial Resources in a Changing World	3
PA 533	Advanced Financial Management for Public and Nonprofit Sectors	3

Public Administration - Policy Planning

PA 537	Crisis Management and Homeland Security	3
PA 538	Information Systems Security and Cyber Crime	3
PA 539	Local Government Management	3
PA 562	Urban and Metropolitan Government	3
PA 578	Planning, Policy-Making, and the Built Environment	3
PA 588	Incident Response, Disaster Recovery, and Business Continuity	3

Structural Engineering

CAE 504	Seismic Retrofit and Earthquake Hazard Reduction	4
CAE 506	Building Envelope Rehabilitation	3
CAE 508	Advanced Bridge Engineering	3
CAE 518	Advanced Reinforced Concrete	3
CAE 520	Buckling of Structures	4
CAE 525	Advanced Steel and Composite Structures	4
CAE 551	Prestressed Concrete	3

Transportation Engineering

CAE 419	Introduction to Transportation Engineering and Design	3
CAE 523	Statistical Analysis of Engineering Data	3
CAE 540	Asphalt and Concrete Mix Design	3
CAE 541	Pavement Evaluation and Management	3
CAE 544	Urban Transportation Planning	4
CAE 545	Traffic Operations and Flow Theory	3
CAE 546	Public Transportation Systems	3
CAE 547	Advanced Traffic Engineering	3
CAE 548	Transportation Systems Management	3
CAE 549	Transportation Economics, Development and Policy	3
CAE 555	Transportation Systems Evaluation	3
CAE 568	Transportation Asset Management	3
CAE 574	Economic Decision Analysis in Civil Engineering	3
CAE 580	Intelligent Transportation Systems	3
CAE 581	Algorithms in Transportation	3
MATH 522	Mathematical Modeling	3
MATH 525	Statistical Models and Methods	3
MATH 542	Stochastic Processes	3
MATH 563	Mathematical Statistics	3
MATH 564	Applied Statistics	3
MATH 565	Monte Carlo Methods in Finance	3

MATH 571	Data Preparation and Analysis	3
MATH 574	Bayesian Computational Statistics	3

Master of Science in Architectural Engineering

The Master of Science in Architectural Engineering couples the architectural engineering coursework curriculum for the advanced study of building science, building systems, and their construction, with a research and thesis-based curriculum in the same fields. Students are expected to develop advanced knowledge and conduct research at a rigorous level. The program will also serve as a foundation for research for students who intend to pursue a doctoral degree.

Curriculum

Degree candidates in the master of science program must complete a minimum of 32 credit hours, six to eight of which must be research and thesis credits. Up to 12 credit hours of 400-level undergraduate coursework may be included in the program with prior adviser approval. An oral defense of the thesis constitutes the comprehensive examination, and no additional written comprehensive examination is required.

Required Courses			(12)
CAE 513	Building Science		3
CAE 574	Economic Decision Analysis in Civil Engineering		3
Select a minimum of two courses from the following:			6
CAE 502	Acoustics and Lighting	3	
CAE 521	Building Illumination Design	3	
CAE 524	Building Enclosure Design	3	
CAE 553	Measurement and Instrumentation in Architectural Engineering	3	
ENVE 576	Indoor Air Pollution	3	
Thesis Research			(6-8)
CAE 591	Research and Thesis for M.S. Degree		6-8
General Electives			(12-14)
Select 12-14 credit hours of electives			12-14

Minimum degree credits required: 32

Master of Science in Civil Engineering

Six technical areas (architectural, construction, geoenvironmental, geotechnical, structural, and transportation engineering) are included in the Master of Science in Civil Engineering program. Degree candidates in the master of science program must complete a minimum of 32 credit hours, six to eight of which are for research and thesis. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the M.S. program with prior adviser approval. An oral defense of the thesis constitutes the comprehensive examination, and no additional written comprehensive examination is required.

Curriculum

Architectural Engineering Emphasis

Required Courses		(12)
CAE 471	Construction Planning and Scheduling	3
CAE 502	Acoustics and Lighting	3
or CAE 521	Building Illumination Design	
CAE 513	Building Science	3
CAE 574	Economic Decision Analysis in Civil Engineering	3
Elective Courses		(12-14)
Select 12-14 credit hours		12-14
Thesis Research		(6-8)
CAE 591	Research and Thesis for M.S. Degree	6-8

Minimum degree credits required: 32

Construction Engineering and Management Emphasis

Required Courses		(12)
CAE 570	Legal Issues in Civil Engineering	3
CAE 571	Lean Construction and Control	3
CAE 574	Economic Decision Analysis in Civil Engineering	3
CAE 577	Construction Equipment Management	3
Elective Courses		(12-14)
Select 12-14 credit hours		12-14
Thesis Research		(6-8)
CAE 591	Research and Thesis for M.S. Degree	6-8

Minimum degree credits required: 32

Geoenvironmental Engineering Emphasis

Required Courses		(13)
CAE 562	Engineering Behavior of Soil	4
CAE 567 Physicochemical Behavior of Soils		3
CAE 589	Groundwater Hydrology and Sampling	3
CAE 590	Geotechnical Landfill Design and Maintenance	3
Elective Courses		(11-13)
Select 11-13 credit hours		11-13
Thesis Research		(6-8)
CAE 591	Research and Thesis for M.S. Degree	6-8

Minimum degree credits required: 32

Geotechnical Engineering Emphasis

Required Courses		(16)
CAE 562	Engineering Behavior of Soil	4
CAE 564	Design of Foundations, Embankments and Earth Structures	4
CAE 565	Rock Mechanics and Tunneling	4
CAE 566	Earthquake Engineering and Soil Dynamics	4
Elective Courses		(8-10)
Select 8-10 credit hours		8-10
Thesis Research		(6-8)
CAE 591	Research and Thesis for M.S. Degree	6-8

Minimum degree credits required: 32

Structural Engineering Emphasis

Required Courses		(13)
MMAE 501	Engineering Analysis I	3
or CAE 514	Mathematical Methods for Structural Engineering	
CAE 503	Advanced Structural Analysis	3
CAE 518	Advanced Reinforced Concrete	3
CAE 525	Advanced Steel and Composite Structures	4
Elective Courses		(11-13)
Select 11-13 credit hours		11-13
Thesis Research		(6-8)
CAE 591	Research and Thesis for M.S. Degree	6-8

Minimum degree credits required: 32

Transportation Engineering Emphasis

Required Courses			(12-13)
Select a minimum of four courses from the following (with adviser consent):			12-13
CAE 523	Statistical Analysis of Engineering Data	3	
CAE 543	Demand Models for Urban Transportation	3	
CAE 544	Urban Transportation Planning	4	
CAE 546	Public Transportation Systems	3	
CAE 548	Transportation Systems Management	3	
CAE 555	Transportation Systems Evaluation	3	
CAE 575	Systems Analysis in Civil Engineering	3	
MATH 525	Statistical Models and Methods	3	
Thesis Research			(6-8)
CAE 591	Research and Thesis for M.S. Degree		6-8
Elective Courses			(12-14)
Select 12-14 credit hours from the following: [1]			12-14
CAE 419	Introduction to Transportation Engineering and Design	3	
CAE 540	Asphalt and Concrete Mix Design	3	
CAE 541	Pavement Evaluation and Management	3	
CAE 545	Traffic Operations and Flow Theory	3	
CAE 547	Advanced Traffic Engineering	3	
CAE 549	Transportation Economics, Development and Policy	3	
CAE 568	Transportation Asset Management	3	
CAE 574	Economic Decision Analysis in Civil Engineering	3	
CAE 580	Intelligent Transportation Systems	3	
CAE 581	Algorithms in Transportation	3	
MATH 522	Mathematical Modeling	3	
MATH 542	Stochastic Processes	3	
MATH 563	Mathematical Statistics	3	
MATH 564	Applied Statistics	3	
MATH 565	Monte Carlo Methods in Finance	3	
MATH 571	Data Preparation and Analysis	3	
MATH 574	Bayesian Computational Statistics	3	

Minimum degree credits required: 32

1 Other courses are allowed but are subject to adviser approval.

Master of Science in Environmental Engineering

This program makes it possible for the student to build a strong foundation in environmental engineering and, through their research, to specialize in one area.

Curriculum

Core Courses		(15)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
Elective Courses		(9-11)
Select 9 to 11 credit hours		9-11
Thesis Research		(6-8)
ENVE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

The student must have a minimum grade point average of 3.0/4.0 in the core areas. Aside from the core courses, coursework may be selected (with adviser approval) to satisfy the needs of the individual student.

Up to 9 credit hours in 400-level courses may be selected in some cases to overcome deficiencies or broaden the student's background. In addition, master's degree students take 6-8 credit hours of research (ENVE 591). The final step in this program is an oral defense of the thesis; no additional written comprehensive exam is required.

Doctor of Philosophy in Civil Engineering

The doctoral degree in civil engineering is awarded upon demonstration of an ability to make substantial creative contributions to knowledge in architectural, construction, geotechnical, structural, or transportation engineering. The full-time doctoral program generally consists of at least two complete years of academic preparation, followed by at least one year of full-time research in residence at the university. The coursework must include 12 credit hours of core courses in the respective fields listed in the section describing the Master of Science in Civil Engineering (p. 82).

To be admitted to candidacy, students must pass a qualifying examination, which involves an oral presentation of two research papers selected by the student's adviser. The qualifying examination is administered by a research committee approved by the chairperson. The exam is diagnostic in nature. The results of the exam will determine the student's potential for success in the Ph.D. program. The department may waive this requirement for students who hold an M.S. degree from Illinois Institute of Technology in the same field. This examination should be completed within three semesters of entry into the program.

The candidate should pass the comprehensive examination at least one year prior to the date of graduation. The comprehensive examination is an oral examination that is administered by a research committee approved by the chairperson. The candidate presents the research proposal and answers questions of a general professional nature. The research project must be in harmony with the interests of the faculty and with the facilities of the department.

Although doctoral research can begin after admission to the Ph.D. program, the major portion of the research should take place after the comprehensive examination is passed and the research proposal is approved by the research committee. Research will be conducted under the supervision of a full-time faculty member and students should work to involve all members of their research committee.

The preliminary thesis draft must meet the approval of all members of the research committee. An oral examination in defense of the thesis is given as an open university seminar. The thesis defense must meet with the approval of the research committee; if it does not, the committee has the authority to determine whether or not to grant a re-examination.

Curriculum

Minimum Credits Required	84
Maximum 400-Level Credit	12
Maximum Transfer Credit	32

Master of Science transfer coursework	(32)
Maximum amount eligible for transfer is 32 credit hours	32

Ph.D. Coursework		(28)
Select 28 credit hours		28
Ph.D. Research		(24)
CAE 691	Research and Thesis for Ph.D. Degree	24
Total Credit Hours		84

Doctor of Philosophy in Environmental Engineering

The doctoral degree in environmental engineering is awarded upon demonstration of an ability to make substantial creative contributions to knowledge in environmental engineering. The full-time doctoral program generally consists of at least two complete years of academic preparation, followed by at least one year of full-time research in residence at the university. The coursework must include 15 credit hours of core environmental engineering courses listed in the section describing the Master of Science in Environmental Engineering (p. 85).

To be admitted to candidacy, students must pass a qualifying examination, which involves an oral presentation of two research papers selected by the student's adviser. The qualifying examination is administered by a research committee approved by the chairperson. The exam is diagnostic in nature. The results of the exam will determine the student's potential for success in the Ph.D. program. The department may waive this requirement for students who hold an M.S. degree from Illinois Institute of Technology in the same field. This examination should be completed within three semesters of entry into the program.

The candidate should pass the comprehensive examination at least one year prior to the date of graduation. The comprehensive examination is an oral examination that is administered by a research committee approved by the chairperson. The candidate presents the research proposal and answers questions of a general professional nature. The research project must be in harmony with the interests of the faculty and with the facilities of the department.

Although doctoral research can begin after admission to the Ph.D. program, the major portion of the research should take place after the comprehensive examination is passed and the research proposal is approved by the research committee. Research will be conducted under the supervision of a full-time faculty member and students should work to involve all members of their research committee.

The preliminary thesis draft must meet the approval of all members of the research committee. An oral examination in defense of the thesis is given as an open university seminar. The thesis defense must meet with the approval of the research committee; if it does not, the committee has the authority to determine whether or not to grant a re-examination.

Curriculum

Minimum Credits Required	84
Maximum Transfer Credit	42

Master of Science transfer coursework		(32)
Maximum amount eligible for M.S. degree transfer is 32 credit hours		32
Required Courses		(15)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
General Electives		(1-13)
Select 1-13 credit hours as needed to achieve total of 84 credit hours		1-13
Ph.D. Research		(24-36)
ENVE 691	Research and Thesis Ph.D.	24-36

Master of Engineering in Environmental Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title	Credit Hours
Core Courses		(24)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3

ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
Select one E3 course from Group A		3
Select two E3 courses from Group B [1]		6
Special Project Research		(2-5)
ENVE 597	Special Problems	2-5
Additional E3 Courses		(3-6)
Select 3-6 credit hours with the approval of adviser		3-6

Minimum degree credits required: 32

[1] In addition to the listed E3 Group B course options, Master of Engineering in Environmental Engineering students may select EMS 504 and CAE 589 as Group B course options.

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3

ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Science in Environmental Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title	Credit Hours
Core Courses		(24)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
Select one E3 course from Group A		3
Select two E3 courses from Group B [1]		6
Elective Courses		(0-2)
Select 0-2 credit hours		0-2
Thesis Research		(6-8)
ENVE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

1 In addition to the listed E3 Group B course options, Master of Science in Environmental Engineering students may select EMS 504 and CAE 589 as Group B course options.

Students may apply up to two 400-level courses to the M.S. degree requirements with their adviser's approval.

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3

ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Doctor of Philosophy in Environmental Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CHE 543	Energy, Environment, and Economics	3
Select 5 E3 courses from Groups A and/or B [1]		15
Ph.D. Research		(24)
ENVE 691	Research and Thesis Ph.D.	24

Minimum degree credits required: 84

1. In addition to the listed E3 Group B course options, Ph.D. in Environmental Engineering students may select EMS 504 and CAE 589 as Group B course options.

Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one E3 professor from outside the student’s department.

E3 Courses

See descriptions under the respective department’s course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3

CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Certificate in Air Resources

This program explores outdoor air quality, causes of outdoor air pollution, and investigative and diagnostic techniques used in outdoor air quality control.

Curriculum

Required Course			(3)
ENVE 570	Air Pollution Meteorology		3
Elective Courses			(9)
ENVE 576	Indoor Air Pollution		3
ENVE 577	Design of Air Pollution Control Devices		3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning		3
Total Credit Hours			12

Certificate in Architectural Engineering

Curriculum

Required Coures			(3)
CAE 513	Building Science		3
Elective Courses			(6)
Select a minimum of two courses from the following:			6
CAE 461	Plumbing and Fire Protection Design	3	
CAE 464	HVAC Systems Design	3	
CAE 502	Acoustics and Lighting	3	
CAE 507	Control of Sound and Vibration in Buildings	3	
CAE 509	Anlys&Dsgn of Acoustic Spaces	3	
CAE 521	Building Illumination Design	3	
CAE 524	Building Enclosure Design	3	
CAE 526	Energy Conservation Design in Buildings	3	
CAE 528	Building Electrical Systems Design	3	
CAE 597	Special Problems	1-20	
Total Credit Hours			9

Certificate in Construction Management

Curriculum

Required Courses			(12)
Select a minimum of four courses from the following:			12
CAE 470	Construction Methods and Cost Estimating	3	
CAE 471	Construction Planning and Scheduling	3	
CAE 472	Construction Site Operation	3	
CAE 473	Construction Contract Administration	3	
CAE 570	Legal Issues in Civil Engineering	3	
CAE 571	Lean Construction and Control	3	
CAE 572	Construction Cost Accounting and Control	3	
CAE 573	Construction Management with Building Information Modeling	3	
CAE 574	Economic Decision Analysis in Civil Engineering	3	
CAE 575	Systems Analysis in Civil Engineering	3	
CAE 577	Construction Equipment Management	3	
CAE 578	Construction Claims Management	3	

CAE 579	Real Estate Fundamentals for Engineers and Architects	3	
Total Credit Hours			12

Certificate in Earthquake and Wind Engineering Design

Curriculum

Required Courses			(12-14)
Select a minimum of four courses from the following:			12-14
CAE 410	Introduction to Wind and Earthquake Engineering	3	
CAE 518	Advanced Reinforced Concrete	3	
CAE 525	Advanced Steel and Composite Structures	4	
CAE 582	Structural Wind and Earthquake Engineering	4	
CAE 583	Performance-Based Structural and Seismic Design of Buildings and Bridges	3	
CAE 586	Seismic Design of Building and Bridge Structures	3	
Total Credit Hours			12-14

Certificate in Hazardous Waste Engineering

This program is an introduction to the characterization of hazardous waste sites, common and innovative remediation techniques, and current issues in hazardous waste engineering.

Curriculum

Required Course			(3)
ENVE 580	Hazardous Waste Engineering		3
Elective Courses			(6)
Select a minimum of two courses from the following:			6
CAE 589	Groundwater Hydrology and Sampling	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 577	Design of Air Pollution Control Devices	3	
Total Credit Hours			9

Certificate in Indoor Air Quality

This program covers sick building syndrome, the causes of indoor air pollution, and investigative and diagnostic techniques used in controlling indoor air quality.

Curriculum

Required Course			(3)
ENVE 576	Indoor Air Pollution		3
Elective Courses			(3)
Select a minimum of one course from the following:			3
CAE 523	Statistical Analysis of Engineering Data	3	
MMAE 452	Aerospace Propulsion	3	
BIOL 514	Toxicology	3	
Total Credit Hours			6

Certificate in Infrastructure Engineering and Management

Curriculum

Required Courses			(6)
PA 501	Essentials for Public Management in a Complex Society: Processes, Structures, and Values		3
PA 551	Public Infrastructure Management		3
Elective Courses			(6)
Select a minimum of two courses from the following (with adviser consent):			6
CAE 408	Bridge and Structural Design	3	
CAE 416	Facility Design of Transportation Systems	3	
CAE 417	Railroad Engineering and Design	3	
CAE 419	Introduction to Transportation Engineering and Design	3	
CAE 471	Construction Planning and Scheduling	3	
CAE 486	Soil and Site Improvement	3	
CAE 508	Advanced Bridge Engineering	3	
CAE 523	Statistical Analysis of Engineering Data	3	
CAE 539	Introduction to Geographic Information Systems	3	
CAE 541	Pavement Evaluation and Management	3	
CAE 544	Urban Transportation Planning	4	
CAE 546	Public Transportation Systems	3	
CAE 548	Transportation Systems Management	3	
CAE 549	Transportation Economics, Development and Policy	3	
CAE 555	Transportation Systems Evaluation	3	
CAE 568	Transportation Asset Management	3	
CAE 574	Economic Decision Analysis in Civil Engineering	3	
CAE 575	Systems Analysis in Civil Engineering	3	
CAE 581	Algorithms in Transportation	3	
CAE 590	Geotechnical Landfill Design and Maintenance	3	
Total Credit Hours			12

Certificate in Transportation Systems Planning

Curriculum

Select a minimum of two courses from the following (with adviser consent):			6
CAE 523	Statistical Analysis of Engineering Data	3	
CAE 544	Urban Transportation Planning	4	
CAE 546	Public Transportation Systems	3	
CAE 548	Transportation Systems Management	3	
CAE 555	Transportation Systems Evaluation	3	
CAE 575	Systems Analysis in Civil Engineering	3	
Select a minimum of two courses from the following (with adviser consent):			6
CAE 416	Facility Design of Transportation Systems	3	
CAE 417	Railroad Engineering and Design	3	
CAE 419	Introduction to Transportation Engineering and Design	3	
CAE 539	Introduction to Geographic Information Systems	3	
CAE 549	Transportation Economics, Development and Policy	3	
CAE 568	Transportation Asset Management	3	
CAE 574	Economic Decision Analysis in Civil Engineering	3	
CAE 581	Algorithms in Transportation	3	
MATH 525	Statistical Models and Methods	3	
MATH 563	Mathematical Statistics	3	
MATH 564	Applied Statistics	3	
MATH 571	Data Preparation and Analysis	3	
Total Credit Hours			12

Certificate in Water and Wastewater Treatment

This program is an introduction to the biological and physical/chemical processes used in water and wastewater treatment, and the design of water and wastewater treatment processes.

Curriculum

Required Courses		(12)
ENVE 513	Biotechnological Processes in Environmental Engineering	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
Total Credit Hours		12

Electrical and Computer Engineering

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Chair
Ashfaq Khokhar

Associate Chair
Jafar Saniie

Faculty with Research Interests
For more information regarding faculty visit the Department of Electrical and Computer Engineering website.

The Department of Electrical and Computer Engineering offers academic programs in advanced study to graduates with technical backgrounds in preparation for careers in industry and in academic research. In addition to the doctoral and master's degrees, which are granted in recognition of research contribution and coursework, the department offers a number of professional master's degrees and certificate programs to enable practicing engineers to pursue continuing education in their areas of interest.

Faculty members are engaged in research in the forefront of their fields, with funding derived from industrial and government research grants and contracts, which provide support to graduate students in the form of research assistantships, in addition to the development and the maintenance of the research facilities. The department also offers a number of fellowships and teaching assistantships on a competitive basis.

Admission to graduate study in one of the programs requires the completion of an undergraduate degree or its equivalent in electrical engineering, computer engineering, or other engineering disciplines from an accredited university. Individuals with backgrounds in other fields of engineering are required to complete courses in the core undergraduate curriculum before commencing graduate work.

For many years, the graduate programs offered by the department have facilitated professionals in industry to advance their knowledge through the pursuit of graduate degrees. IIT Online, the interactive distance learning facility of Illinois Institute of Technology, provides support to continuing education by making numerous courses accessible via the Internet and a regional multi-channel television network serving almost 20 industrial organizations in the metropolitan Chicago area.

Research Centers and Facilities

The department operates research laboratories for work in CAD (Computer-Aided Design), for VLSI (Very- Large-Scale Integration), and SoC (System-on-Chip) circuit design, communications, computer networking, wireless networks, network security, cloud computing, cyber physical systems, embedded computing, image processing, medical imaging, data mining, microwave electronics, power systems, smart grids, signal processing, and ultrasonic imaging. The Electric Power and Power Electronics Center supports research initiatives with support from industry and government in the areas of power systems, power electronics, electric machines, motor drives, and vehicular power systems. The Medical Imaging Research Center conducts research in numerous forms for imaging and data analysis, and includes the Advance X-ray Imaging Laboratory (AXIL), which is developing new types of x-ray devices. The department also collaborates with and utilizes the research resources of the Pritzker Institute of Biomedical Science and Engineering and nearby national laboratories.

The department has state-of-the-art computer systems to enhance and extend the generally available system in the university. A primary resource is a network of more than 100 high-performance workstations, file servers, and computer servers, computer clusters for both CPU and GPU (Graphics Processing Unit) based computing, running the Windows/Unix/Linux/OS X operating system. With mass storage, CD-ROM drives, tape drives, and accelerated graphics, these systems provide students and researchers with an array of software tools including: programming languages (C, C++, Java, FORTRAN, Python, Perl, CUDA, Open CL, etc.), software development tools, software and hardware simulators, and electronic computer-aided design packages from companies such as Cadence, Synopsys, Avanti, Synplicity, Xilinx, Altera, Mentor Graphics, EPRI, and ESCA.

In addition to the workstations, the department maintains a collection of PCs for ECE students, including a set of machines that can be dedicated to hardware/software projects. The computers are connected via high-speed Ethernet, (wired and wireless), which in turn is connected to the university's backbone and the Internet.

Research Areas

Active research programs are conducted in the general areas of communications systems, wireless networks, computer systems, computer networks, wireless security, cloud computing and micro-electronics, electromagnetics and electronics, power and control systems, and signal and image processing.

Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental and sustainability issues and economic forces that drive technology choice.

The E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project or additional energy and sustainability courses for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, of sustainability issues related to energy extraction, conversion, and utilization, and of the impact of sustainability principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of sustainability and regulatory issues to enable them to make more viable technology choices.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0

TOEFL minimum score: 550/213/80[1]

MAS/M.S.

1. GRE score:
   1100 (quantitative + verbal)
   3.5 (analytical writing)

2. New GRE score:
   304 (quantitative + verbal)
   3.5 (analytical writing)

Ph.D.

1. GRE score:
   1100 (quantitative + verbal)
   3.5 (analytical writing)
2. New GRE score:
   304 (quantitative + verbal)
   3.5 (analytical writing)

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. Professional master's degrees in electrical and computer engineering, network engineering, telecommunication and software engineering, power engineering, biomedical images and signals, VLSI and microelectronics, and electricity markets do not require GRE scores for applicants who hold undergraduate degrees from universities in the United States with a minimum cumulative GPA of 3.0/4.0.

Admission to the master's degree programs normally requires a bachelor's degree from an accredited institution in electrical engineering or computer engineering. Applicants with backgrounds in other fields with proficiency in engineering sciences, physics, mathematics, or computer science, gained through prior coursework or professional experience, are also eligible for admission, but will be required to demonstrate proficiency in the subject matter covered in undergraduate courses that are prerequisites for the chosen graduate program.

Proficiency may be demonstrated by passing a written exam or by taking and passing, with a grade of B or better, prerequisite undergraduate courses at the university. Specific course prerequisites for each degree program are listed within the program description.

Admission to the doctoral program requires a master's degree. Each entering degree-seeking graduate student is assigned a temporary academic adviser who will provide initial guidance to the candidate. As their research and other academic interests become defined, students may opt to select a new permanent adviser.

Non-degree graduate students should consult with the department adviser. Students are responsible for following the guidelines of the graduate programs set by the department, in conjunction with the regulations of the Graduate College.

[1] Paper-based test score/computer-based test score/internet-based test score.

Degrees Offered

- Master of Biomedical Imaging and Signals (p. 108)
- Master of Electrical and Computer Engineering (p. 109)
- Master of Network Engineering (p. 111)
- Master of Power Engineering (p. 113)
- Master of VLSI and Microelectronics (p. 116)
- Master of Science in Computer Engineering (p. 117)
- Master of Science in Electrical Engineering (p. 120)
- Doctor of Philosophy in Computer Engineering (p. 129)
- Doctor of Philosophy in Electrical Engineering (p. 129)

Dual Degree Program

- Master of Science in Computer Engineering and Electrical Engineering (p. 123)

Joint Degree Programs

- Master of Electricity Markets (with Finance) (p. 110)
- Master of Telecommunications and Software Engineering (with Computer Science) (p. 114)

Interdisciplinary Programs

- Master of Electrical and Computer Engineering with Specialization in Energy/Environment/Economics (E3) (p. 130)
- Master of Science in Electrical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 132)
- Doctor of Philosophy in Electrical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 130)

Certificate Programs

Certificate programs provide a student with post baccalaureate knowledge in an area of specialization within electrical and computer engineering. Students in these programs register as certificate non-degree seeking students. Certificates are granted upon completion of all course requirements in the chosen specialization area, as listed below, with a minimum GPA of 3.0. Certificate programs must be completed within five years.

It is the student’s responsibility to meet all course prerequisites. Any student admitted to a master’s degree program offered by the department may apply coursework completed in the certificate program toward the master’s degree requirements.

- Advanced Electronics (p. 137)
- Applied Electromagnetics (p. 137)
- Communication Systems (p. 138)
- Computer Engineering (p. 138)
- Control Systems (p. 139)
- Electricity Markets (p. 139)
- Power Electronics (p. 140)
- Power Engineering (p. 140)
- Signal Processing (p. 141)
- Wireless Communications Engineering (p. 142)

Course Descriptions

ECE 502
Basic Network Theory
Steady-state analysis of linear networks. Introduction to topology and the derivation of mesh, nodal & terminal pair relations using topological concepts with applications to computer-aided analysis of networks. Numerical techniques for network analysis and optimization.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 504
Wireless Communication System Design
Fundamentals of first (1G), second (2G), third (3G), and future generation cellular communication systems. This course covers the transition from 1G to 3G systems. Topics included are speech and channel encoders, interleaving, encryption, equalization, modulation formats, multi-user detection, smart antennas, technologies that are used in these transitions, and future generations of cellular systems. Compatibility aspects of digital cellular systems are discussed along with a review of the standards for the industry. TDMA and CDMA systems are covered in detail.
Prerequisite(s): [(ECE 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 505
Applied Optimization for Engineers
Principles of optimization for practical engineering problems, linear programming, nonlinear unconstrained optimization, nonlinear constrained optimization, dynamic programming.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 506
Analysis of Nonlinear Systems
Graphical and analytical methods, phase plane and singular points, periodic oscillations and limit cycles, forced nonlinear systems, jumps subharmonics and frequency entrainment; stability analysis using Liapunov, Popov and circle criteria; introduction to describing functions.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 507
Imaging Theory & Applications
Image formation methods including optical (photography), tomography, image formation with arrays of sensors, interferometry, and surface imaging. Technologies of image acquisition including digital cameras, radar/sonar and medical imaging techniques such as magnetic resonance imaging, computed tomography, positron emission tomography, optical imaging, electroencephalography, and magnetoencephalography. Throughout the semester, the course will also focus on the reconstruction of images based on the raw data obtained from various imaging techniques.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 508
Video Communications
This course covers the fundamentals of video coding and communications. The principles of source coding for the efficient storage and transmission of digital video will be covered. State-of-the-art video coding standards and error-resilient video coding techniques will be introduced. Recent technologies for robust transmission of video data over wired/wireless networks will be discussed. A detailed overview of architectural requirements for supporting video communications will be presented. Error control and cross-layer optimization techniques for wireless video communications will be covered.
Prerequisite(s): [(ECE 437 and ECE 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 509
Electromagnetic Field Theory
Electric and magnetic fields produced by charge and current distributions. Solution of Laplace's and Poisson's equations, time-varying fields and electromagnetic waves. Applications to waveguides and antennas.
Prerequisite(s): [(ECE 307)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 511
Analysis of Random Signals
Probability theory, including discrete and continuous random variables, functions and transformations of random variables. Random processes, including correlation and spectral analysis, the Gaussian process and the response of linear systems to random processes.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 513
Communication Engineering Fundamentals
Review of probability and random processes. AM with noise, FM with noise. Introduction to digital communication. Source coding, signal space analysis, channel modulations, optimum receiver design, channel encoding.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 514
Digital Communication Principles
Information transmission fundamentals, including capacity, entropy, Shannon's theorems and source coding. Introduction to rate distortion theory. Advanced digital modulation and demodulation techniques, performance measures. Channel coding and introduction to trellis coded modulation.
Prerequisite(s): [(ECE 511 and ECE 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 515

Modern Digital Communications

Review of modulation and coding. Trellis coded modulation. Digital signaling over fading multipath channels. Spread spectrum signals for digital communications. Multiple access systems, time-division multiple access, code-division multiple access, and frequency-division multiple access. Advanced communications systems.

Prerequisite(s): [(ECE 511 and ECE 513)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 516

Coding for Distributed Storage Systems

Distributed storage systems, such as data centers, are becoming a vital infrastructure of today's society by allowing to store reliably large amounts of data and make it accessible anywhere and anytime. The goal of this course is to train students with the different mathematical and engineering tools that are needed when studying and designing codes and algorithms for data reliability and security in these large-scale systems. The course will cover relevant topics in information theory, coding theory, graph theory, and wireless communications in addition to the active on-going research in this area.

Prerequisite(s): [(ECE 511)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 519

Coding for Reliable Communications

Encoders and decoders for reliable transmission of digital data over noisy channels. Linear block codes, cyclic codes, BCH codes, convolutional codes. Burst error correcting codes. Maximum likelihood decoding of convolutional codes. Performance of block and convolutional codes in additive white Gaussian channel.

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 520

Information Theory and Applications

Definition of information; coding of information for transmission over a noisy channel including additive Gaussian noise channels and waveform channels; minimum rates at which sources can be encoded; maximum rates at which information can be transmitted over noisy channels. Information theoretic security. Modern applications of information theory in communications, networking, and other fields.

Prerequisite(s): [(ECE 511)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 521

Quantum Electronics

The Schrodinger equation. Matrix formulation. Quantization of lattice vibrations and electromagnetic fields. Optical beams and resonators. The interaction of radiation and atomic systems. Lasers. Optical waveguides and devices. Frequency conversion. Quantum noise . Same as PHYS 521.

Prerequisite(s): [(ECE 307)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 522

Electromagnetic Compatibility

Development of design procedures for minimizing interference between electronic circuits and systems. sources of conducted and radiated interference. Interference coupling mechanisms. Shielding theory. Grounding, bonding and filtering methods. special equipment design procedures. Problems associated with digital equipment. Measurement methods.

Prerequisite(s): [(ECE 307)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 524

Advanced Electronic Circuit Design

RF amplifiers and oscillators. Low and high power RF amplifier design techniques. Stability of amplifiers. LC and crystal oscillators. FM demodulators and limiters. Mixer design. Circuit design to minimize intermodulation and other forms of distortion.

Prerequisite(s): [(ECE 309 and ECE 312)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 525

RF Integrated Circuit Design

Essentials of contemporary RF CMOS integrated circuit analysis and design. Typical RF building blocks in CMOS and BiCMOS technologies, including passive IC components, MOS transistors, RLC tanks, distributed networks, RF amplifiers, voltage reference and biasing circuits, LNA, mixers, power amplifiers, and feedback networks. RF device modeling, Smith chart applications, bandwidth estimation, and stability analysis techniques. RF IC team design projects.

Prerequisite(s): [(ECE 312)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 526

Active Filter Design

Analysis and design of linear active filters with emphasis on realizations using operational amplifiers. Sensitivity analysis. Switched capacitor filters.

Prerequisite(s): [(ECE 308 and ECE 312)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 527

Performance Analysis of RF Integrated Circuits

Essentials of analysis techniques for nonlinear effects and noises in contemporary RF integrated circuit design. Nonlinear and distortion behaviors including inter-modulation, cross-modulation, harmonics, gain compression, desensitization, spurious, etc. Noise effects including thermal, short, Flicker, burst noises, etc. RF IC devices and circuits including resistors, capacitors, inductors, diodes, BJTs, FETs, low-noise amplifiers, mixers, power amplifiers, etc. Analysis skills for single-stage and multiple-stage networks. RF IC team design projects.

Prerequisite(s): [(ECE 312)]

Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 529
Advanced VLSI Systems Design
Advanced design and applications in VLSI systems. The topics of this course include design tools and techniques, clocking issues, complexity management, layout and floor planning, array structures, testing and testability, advanced arithmetic circuitry, transcendental function approximations, architectural issues, signal processing architecture and sub-micron design. Design projects are completed and fabricated by student teams.
Prerequisite(s): [(ECE 429)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 530
High Performance VLSI IC Systems
Background and insight into some of the most active performance-related research areas of the field is provided. Issues covered include CMOS delay and modeling, timing and signal delay analysis, low power CMOS design and analysis, optimal transistor sizing and buffer tapering, pipelining and register allocation, synchronization and clock distribution, retiming, interconnect delay, dynamic CMOS design techniques, asynchronous vs. synchronous tradeoffs, BiCMOS, low power design, and CMOS power dissipation. Historical, primary, and recent papers in the field of high-performance VLSI digital and analog design and analysis are reviewed and discussed. Each student is expected to participate in the class discussions and also lead the discussion surveying a particular topic.
Prerequisite(s): [(ECE 429)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 531
Linear System Theory
Linear spaces and operators, single and multivariable continuous dynamical systems, controllability and observability. Canonical forms, irreducible realizations. Synthesis of compensators and observers. Composite systems, elements of stability.
Prerequisite(s): [(ECE 308)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 533
Robust Control
Uncertain systems; multi-variable control design; linear fractional transformation; uncertainties and small-gain theorem; H-infinity norm; algebraic Riccati equations; H-infinity control; optimality and robustness; design considerations; loop shaping; uncertainty and disturbance estimator; applications and examples.
Prerequisite(s): [(ECE 438)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 535
Discrete Time Systems
Discrete systems. Sampling and reconstruction procedures. Transform techniques of analysis and synthesis. State space techniques. Discrete controllability, observability and stability. Compensation and digital controllers.
Prerequisite(s): [(ECE 438)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 538
Renewable Energies
Various renewable energy sources such as solar systems, wind powered systems, ocean tides, ocean waves, and ocean thermal are presented. Their operational principles are addressed. Grid connected interfaces for such systems are explained. Research and Simulation mini-projects with emphasis on either machine design, or power electronic circuit analysis, design, and controls, or grid connected renewable systems are assigned to student groups.
Prerequisite(s): [(ECE 311)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 539
Computer Aided Design of Electric Machines
Fundamentals of energy conversion will be discussed, which are the foundation of efficient design and operation of motors & generators in modern day automotive, domestic and renewable energy systems. It will further investigate the principles of structural assessment, electromagnetic analysis, dimensional and thermal constraints. Finite Element Analysis (FEA) software-based design projects will be used to model the performance and operation of electric machines.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 540
Reliability Theory and System Implementation
Basic probability and modeling techniques on component, subsystem and system levels. MTBF, MTTR and downtime. Hardware, software and cost considerations. Switching systems. Multicomputer and memory configurations.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 541
Performance Evaluation of Computer Networks
Introduction to performance evaluation techniques for computer and communication networks. Little's theorem, birth-death processes, M/G/1 queue, product from queuing networks, approximation techniques for G/G/1 queues and non-product form queuing networks. Discrete event simulations, generation of random variables, variance reduction techniques and general purpose simulation languages.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 542
Design and Optimization of Computer Networks
This course provides comprehensive introduction to network flows with an integrative view of theory, algorithms, and applications. It covers shortest path, maximum flow, and minimum cost flow problems, including a description of new and novel polynomial-time algorithms. It also covers topics from basic network design to protection and restoration design, to multi-layer network design while taking into account routing and flow requirement as applicable in different network architecture, protocol and technologies.
Prerequisite(s): [(ECE 407)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 543
Computer Network Security
This course introduces network security by covering topics such as network-related security threats and solutions, private- and public-key encryptions, authentication, digital signatures, Internet Protocol security architecture (IPSEC), firewalls, network management, email and web security.
Prerequisite(s): [(ECE 407) OR (ECE 408)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 544
Wireless and Mobile Networks
This course provides an overview of different wireless and mobile network standards and systems. The topics covered include cellular networks, satellite networks, wireless local area networks, wireless personal area networks, mobile IP, ad hoc networks, sensor networks, wireless mesh networks and wireless network security.
Prerequisite(s): [(ECE 407) OR (ECE 408)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 545
Advanced Computer Networks
Fundamentals of computer communication networks. Overview of data communication networks and protocol architectures with emphasis on the Internet protocols and network elements. Principles of network and protocol design; error detection and correction, flow control and congestion control, delay and throughput models, QoS, service support and application interface (including remote procedure call mechanisms). Local and Wide Area Networks (Ethernet, FDDI, Wireless LAN, ATM and Internet). LAN and Wan interconnection using bridges, routers, switchers and gateways. Routing in data networks. Network and protocol design to support multimedia and multicasting connections. Network application security.
Prerequisite(s): [(ECE 407) OR (ECE 408)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 546
Wireless Network Security
This course focuses on selected research topics current interest in wireless network security. This course will cover security and privacy issues in wireless systems, including cellular networks, wireless LAN, mobile ad hoc networks (MANET), wireless mesh networks, sensor networks, vehicular networks, RFID, and ubiquitous computing.
Prerequisite(s): [(ECE 543)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 547
Wireless Networks Performance Analysis
This course deals with the performance analysis techniques for the main types of wireless networks used today including cellular communication networks, wireless local area networks (WLAN), zigbee wireless networks, and wireless mesh networks. The course not only discusses the details of the related IEEE standards but also focuses on mathematical modeling and analysis to compute the quality of service metrics as well as resource utilization efficiency. Key topics include cellular system design, mobility management, conflict-free medium access, contention-based medium access, Markov chain modeling for 802.11, fixed-point based analysis, 802.15.4 modeling and analysis, and wireless mesh network capacity analysis.
Prerequisite(s): [(ECE 544)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 548
Energy Harvesting
Various harvesting techniques such as solar, ocean ides, vibration, linear motion, radio frequency, passive and active human power generation are presented. Their operational principles are addressed. Research and simulations mini-projects with emphasis on power electronic circuit analysis, design, and controls are assigned to student groups.
Prerequisite(s): [(ECE 311)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 549
Motion Control Systems Dynamics
Fundamentals and applications of motion control systems, control techniques for high precision motion control, state variable feedback of linear and nonlinear systems, multivariable systems, physical system modeling, graphical analysis, and numerical analysis, and system performance analysis.
Prerequisite(s): [(ECE 438)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 550
Power Electronic Dynamics and Control
Modeling an analysis of solid-state switching circuits, parallel module dynamics, multi-converter interactions, resonant converters, feedback control, stability assessment, reduced parts converters, integrated structures, programmable switching regulators, digital switch-mode controllers, and power electronic converter-on-a-chip development.
Prerequisite(s): [(ECE 411)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 551
Advanced Power Electronics
Advanced power electronic convertors, techniques to model and control switching circuits, resonant converts, Pulse-Width-Modulation (PWM) techniques, soft-switching methods, and low-voltage high-current design issues are studied. Single-phase and multi-phase, controlled and uncontrolled rectifiers and inverters with different operating techniques and their design and control issues are explained.
Prerequisite(s): [(ECE 411)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 552
Adjustable Speed Drives
Fundamentals of electric machines, basic principles of variable speed controls, field orientation theory, direct torque control, vector of AC drives, induction machines, switched reluctance and synchronous reluctance motors, permanent magnet brushless DC drives, converter topologies of DC and AC drives, and sensorless operation.
Prerequisite(s): [(ECE 411)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 553
Power System Planning
Model development. Interchange capability, interconnections, pooling. Economic generator size and site selection. Concept of reserves, transformers, relays and circuit breakers. Reactive planning AC and DC systems are explored thoroughly from a planning standpoint.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 554
Power System Relaying
Principles of relay protection for faults on transmission lines and in transformers, rotating machines and other equipment. Use of over current, differential, distance , wire-pilot, carrier-pilot and microwave-pilot relaying systems. Solid-state relays and computer control of relaying. Determination of short-circuit currents and voltages from system studies.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 555
Power Market Operations
Market Design in Restructured Power Systems, Short-term Load Forecasting, Electricity Price Forecasting, Price Based Unit Commitment, Arbitrage in Electricity Market, Market Power Analysis, Asset Valuation and Risk Analysis, Security Constrained Unit Commitment, Ancillary Services Auction Market Design, Power Transmission Pricing, Regional Transmission Organizations.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 556
Power Market Economics and Security
This course covers simulation and scheduling tools used in restructured power system for studying the economics and security of power systems. Topics include modeling of generating units (thermal units, combined-cycle units, fuel-switching/blending units, hydro units, pumped-storage units, photovoltaic, wind), Lagrangian Relaxation-based scheduling, mixed integer programming-based scheduling, and Benders decomposition-based transmission security analyses. The simulation and scheduling tools consider different time scales including on-line security, day-ahead, operational planning, and long-term. The simulation and scheduling tools consider interdependency of supply (such as gas, water, renewable sources of energy) and electricity systems.
Prerequisite(s): [(ECE 420)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 557
Fault-Tolerant Power Systems
Critical fault events in a large power system, sparsity techniques. Contingency screening process. Modeling of local controls in load flow. Adaptive localization method. Injection outage analysis. Security constrained dispatch. LP-based OPF. Real-time security analysis. Dynamic security analysis.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 558
Power System Reliability
The concept of reliability, reliability indices, component reliability, generation capacity reserve evaluation, transmission system reliability, bulk power system reliability, distributed system reliability, reliability modeling in context.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 559
High Voltage Power Transmission
Detailed analysis of transmission and distribution systems. Design of high voltage transmission lines and cables, as well as distribution lines. Flexible AC transmission Systems (FACTS) and high voltage DC links.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 560
Power Systems Dynamics and Stability
The transient stability problem, acceleration equations, stability criteria, two-machine and multimachine problems. Perturbation analysis, eigenvalue sensitivity, Liapunov theory and application to power systems stability.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 561
Deregulated Power Systems
Overview of key issues in electric utilities restructuring, Poolco model, bilateral contracts, market power, stranded costs, transmission pricing, electric utility markets in the United States and abroad, OASIS, tagging electricity transactions, electric energy trading, risk in electricity markets, hedging tools for managing risks, electricity pricing, volatility in power markets, and RTO.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 562
Power System Transaction Management
Power interchange transaction management in the deregulated electric power industry. Course topics include: power system security assessment, total and available transfer capability (TTC/ATC), transaction management system (TMS), transaction information system (TIS), tagging calculator (IDC), congestion management, transmission loading relief (TLR).
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 563
Computational Intelligence in Engineering
Introduction to soft computing, fuzzy set theory, neural networks, genetic algorithms, intelligent software agents, comparisons with traditional alternatives, and advanced engineering applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 564
Control and Operation of Electric Power Systems
Unit commitment and application of dynamic programming, fuel budgeting and planning, probabilistic production cost modeling, hydrothermal coordination, power system security and application of expert systems, state estimation, optimal power flow, interchange evaluation and power pools, reactive power planning.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 565
Computer Vision and Image Processing
Multidimensional sampling and discrete Fourier transform; Image segmentation; Object boundary (edge) detection and description; shape representation and extraction; Matching and recognition; Image registration; Camera geometry and stereo imaging; Morphological processing; Motion detection and compensation; Image modeling and transforms; Inverse problems in image processing (restoration and reconstruction).
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 566
Statistical Pattern Recognition
Review of appropriate math: multidimensional probability, covariance matrices, whitening transformation, diagonalization, eigenvectors, eigenvalues. Two-class and multi-class pattern separation using maximum likelihood and MAP. Linear discriminant analysis. Perception algorithm and its extensions. Feature extraction algorithms. Clustering algorithms. Introduction to neural nets. Hopfield, Hamming, feed forward models. Training of neural nets.
Prerequisite(s): [(ECE 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 567
Statistical Signal Processing
Detection theory and hypothesis testing. Introduction to estimation theory. Properties of estimators, Gauss-Markov theorem. Estimation of random variables: conditional mean estimates, linear minimum mean-square estimation, orthogonality principle, Wiener and Kalman filters. Adaptive filtering. LMS algorithm: properties and applications.
Prerequisite(s): [(ECE 511 and MATH 333)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 568
Digital Speech Processing
Review of discrete statistical signal analysis. Acoustic aspects of speech and hearing. Digital models of speech production. Short-time processing in time and frequency domains. Waveform encoding and linear predictive coding of speech. Estimation of fundamental speech parameters. Applications including automatic speech recognition and enhancement.
Prerequisite(s): [(ECE 437 and ECE 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 569
Digital Signal Processing II
Review of basic DSP theory. Design of digital filters: FIR, IIR, frequency-transformation methods, optimal methods. Discrete Fourier Transform (DFT) and Fast Fourier Transform algorithms. Spectral estimation techniques, classical and parametric techniques. AR, MA, ARMA models. Estimation algorithms. Levinson, Durbin-Levinson and Burg's algorithms. eigenanalysis algorithms for spectral estimation.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 570
Fiber-Optic Communication Systems
Physics of optical fiber, composition, dimensioning, coupling, attenuation, dispersion. Electro-optical conversion devices. (ILDs, LEDs, APDs, PINs). Circuit considerations. Modulation techniques and implications. Overall system considerations. Coherent techniques.
Prerequisite(s): [(ECE 307 and ECE 312)]AND[(ECE 403)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 571
Nanodevices and Technology
Electronic properties and quantum effects. Dielectric, magnetic, and optical properties and their characterizations. Individual nanoparticles and clusters. Carbon nanotubes. Solid disordered nanostructures. Nanostructured crystals. Quantum wells, wires, and dots. Giant magnetoresistance. Material processing techniques. Devices and systems based on nanostructures. Prerequisite: Knowledge in quantum mechanics and thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 575
Electron Devices
Electronic properties of solids. Properties of p-n junctions and junction devices. Gunn diode and IMPATT devices. Junction transistors. Schottky diode and MESFET. The MOS capacitor and MOSFET. Light-emitting diodes and junction lasers. Velocity modulation and bunching in electron beams. Klystrons, magnetrons and other microwave thermionic devices.
Prerequisite(s): [(ECE 307 and ECE 312)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 576
Antenna Theory
Plane and spherical waves. Electric and magnetic dipoles. Radiation patterns and impedance characteristics of antennas in free space and over perfect ground. Linear and planar driven antenna arrays. Yagi-Uda parasitic arrays.
Prerequisite(s): [(ECE 307) OR (ECE 421) OR (ECE 423)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 578
Microwave Theory
Microwave field theory. Propagation, reflection and refraction of plane waves. Anisotropic media. Impedance concept. Hollow, surface-wave and dielectric wave guides. Discontinuities in wave guides. Microwave resonators. Transmission lines. Microwave circuit theory.
Prerequisite(s): [(ECE 421) OR (ECE 423)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 580
Elements of Sustainable Energy
This course covers cross-disciplinary subjects on sustainable energy that relate to energy generation, transmission, distribution, and delivery as well as theories, technologies, design, policies, and integration of sustainable energy. Topics include wind energy, solar energy, biomass, hydro, nuclear energy, and ocean energy. Focus will be on the integration of sustainable energy into the electric power grid, the impact of sustainable energy on electricity market operation, and the environmental impact of sustainable energy.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 581
Elements of Smart Grid
This course covers cross-disciplinary subjects on smart grid that relates to energy generation, transmission, distribution, and delivery as well as theories, technologies, design, policies, and implementation of smart grid. Topics include: smart sensing, communication, and control in energy systems; advanced metering infrastructure; energy management in buildings and home automation; smart grid applications to plug-in vehicles and low-carbon transportation alternatives; cyber and physical security systems; microgrids and distributed energy resources; demand response and real-time pricing; and intelligent and outage management systems.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 582
Microgrid Design and Operation
Microgrids are the entities that are composed of at least one distributed energy resource and associated loads which not only operates safely and efficiently within the local power distribution network but also can form intentional islands in electrical distribution systems. This course covers the fundamentals of designing and operating microgrids including generation resources for microgrids, demand response for microgrids, protection of microgrids, reliability of microgrids, optimal operation and control of microgrids, regulation and policies pertaining to microgrids, interconnection for microgrids, power quality of microgrids, and microgrid test beds.
Prerequisite(s): [(ECE 418) OR (ECE 419)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 583
High Speed Computer Arithmetic
This course covers computer arithmetic as applied to general-purpose and application-specific processors. The focus is on developing high-speed arithmetic algorithms and understanding their implementation in VLSI technology at the gate level. Topics include fixed and floating point number systems, algorithms and implementations for addition, subtraction, multiplication, division, and square root, floating point operations, elementary function approximation, low-power design, error analysis, and interval arithmetic..
Prerequisite(s): [(ECE 446) OR (ECE 485)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 584
VLSI Architecture for Signal Processing and Communication Systems
This course aims to convey knowledge of advanced concepts in VLSI signal processing. Emphasis is on the architectural research, design and optimization of signal processing systems used in telecommunications, compression, encryption and coding applications. Topics covered include the principles of datapath design; FIR and IIR filtering architectures; communication systems including OFDM, multirate signal processing; fast transforms and algorithms including fast Fourier transform; discrete cosine transform; Walsh-Hadamard transform; and wavelet transform. Furthermore, advanced computer arithmetic methods including Galois fields, CORDIC, residue number systems, distributed arithmetic, canonic signed digit systems and reduced adder graph algorithms are examined.
Prerequisite(s): [(ECE 429 and ECE 437)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 585
Advanced Computer Architecture
Design, Analysis and Performance of High-Performance Computer Architectures; High Speed memory Systems: Cache Design and Analysis; Modeling Cache Performance; Instruction Level Parallelism, Cache-only Memory Architectures, Classification of Parallel Architectures; Systolic and Data Flow Architectures; Multiprocessor Performance; and Multiprocessor Iterations.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 586
Fault Detection in Digital Circuits
Essential elements in testing and testability of digital designs. Automatic tests generation algorithms and fault-simulation methods. Design methodologies to increase testability and decrease test generation costs. Techniques for built-in testing.
Prerequisite(s): [(ECE 446)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 587
Hardware/Software Codesign
Computer-aided techniques for the joint design of hardware and software: specification, analysis, simulation and synthesis. Hardware/software partitioning, distributed system cosynthesis, application-specific instruction set design, interface cosynthesis, timing analysis for real-time systems.
Prerequisite(s): [(CS 201 and ECE 441)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 588
CAD Techniques for VLSI Design
Overview of techniques and algorithms used in Computer-Aided Design (CAD) for VLSI circuits. Physical CAD tools, including placement, routing, symbolic layout and compaction. High-level CAD tools, including logic synthesis, silicon compilers and high-level synthesis. Recent developments in the field. Design, implementation and performance analysis of prototype CAD tools.
Prerequisite(s): [(ECE 429)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 589
Computer-Aided Design of Analog IC
Analog IC design optimization algorithm such as equation-based optimization and simulation-based optimization algorithms, design automation tools such as harmonic balance, projection-based surface response estimation, shooting methods, etc. will be introduced. Research and mini-projects with emphasis on analog integrated circuit design and optimization algorithms using state-of-the art tools are assigned to student groups.
Lecture: 3 **Lab:** 0 **Credits:** 3

ECE 591
Research and Thesis for Masters Degree
Credit: Variable

ECE 593
Masters Electrical and Computer Engineering Seminar
Seminar course for Master students.
Lecture: 1 **Lab:** 0 **Credits:** 0

ECE 594
Special Projects
Special projects.
Credit: Variable

ECE 597
Special Problems
Credit: Variable

ECE 600
Continuation of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

ECE 691
Research and Thesis for Ph.D.
Credit: Variable

ECE 693
Doctoral Electrical and Computer Engineering Seminar
Seminar course for Ph. D. students.
Lecture: 1 **Lab:** 0 **Credits:** 0

ECE 708
Technologies for Long-Term Evolution of Wireless Communications Networks
The course discusses technologies used in long-term evolution (LTE) wireless communications systems. Fundamentals of multiple-input/multiple-output (MIMO) wireless communication systems and orthogonal frequency division modulation (OFDM) are covered. Transmission diversity concepts and principles of space-time coding are introduced. The fundamentals of space-time block and trellis coded modulation (STBCM and STTCM) are introduced along with performance analysis, code design, and simulation results. A comparison of various design techniques in different propagation environments is presented. Applications to MIMO/OFDM systems are discussed.
Prerequisite(s): [(ECE 513)]
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 719
Theory and Applications of Linear Optimization in Wireless Networks
This short course covers both the fundamental of linear optimization and applications in wireless networking research, emphasizing not only the optimization methodology but also the underlying mathematical structures. In addition to the fundamental contents of simplex method, duality theory, and network flow problems, this course also covers the integer programming techniques. This course discusses the applications of linear optimization in the wireless network, including wireless mesh networks, multi-radio multi-channel networks, and cognitive radio networks.
Prerequisite(s): [(ECE 407) OR (ECE 408)]AND[(MATH 477)]
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 721
Introduction to Wireless Cooperative Communications and Applications
The course gives an introduction to wireless cooperative communication networks from the perspective of the channel and physical layer. It discusses cooperative networks protocols and application of these. It will deal with wireless channels and relay networks. Transparent and regenerative physical layer algorithms will be discussed to facilitate the analysis of different architectures. Use of distributed space time codes, multiplexing, and orthogonal frequency division multiplexing will be analyzed to achieve multi-dimensional diversity (path, frequency, and time), reduced interference, and improved QoS.
Prerequisite(s): [(ECE 403)]
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 735
Cellular Long Term Evolution
Cellular Long Term Evolution (LTE) is a key wireless broadband technology considered as the primary path towards the next generation networks (NGNs). It is generally considered as the dominant wireless technology meeting the seamless, mobile Internet access needs of the upcoming Quadruple Play applications. This short course covers the applications, requirements, architecture, radios and antennas, protocols, network operations and management, and evolution for the LTE technology. Key topics include the functions and interfaces of the protocol layers, Quality of Service (QoS), security, network signaling, infrastructure, user equipment, spectrum, throughput, and coverage. Discussion includes the modulation schemes, frame structure, antenna and radio, and subcarrier and bandwidth allocation methods. End-to-end scenarios on connection setup, interworking with existing 3G cellular, WiFi, and WiMAX networks, and handovers are discussed. Testing and integration issues, limitations, and challenges are also mentioned. Comparative analysis with respect to WiMAX and ultra mobile broadband (UMB) are covered. The likely migration paths from current wireless and wireline networks to LTE and related HSOPA and SAE architectures are discussed.
Lecture: 1 **Lab:** 0 **Credits:** 1

ECE 738
Information Technology
Probability and Random Process Information theory addresses information theoretic limits on data compression and reliable data communications in the presence of noise. It has fundamental contribution in communications, networking, statistical physics, computer science, statistical inference, and probability and statistics. It covers entropy, mutual information, fundamental limits on data compression, Huffman codes, channel capacity, and channel coding.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 739
Broadband Access -- Options and Analysis
This short course deals with requirements, options, architecture, and issues relating to the Next Generation broadband networks. The focus is on the key wireline and wireless access options with specific emphasis on its applicability to multimedia applications. The requirements placed by upcoming services on access are introduced. For the major access options, the key topics include capabilities, architectures, protocol structures, Quality of Service (QoS), security, user equipment, spectrum, throughput, and coverage. The associated signaling and modulation schemes, transport technologies and characteristics, end-to-end scenarios, and interworking are addressed. Comparative analysis in terms of various application profiles involving voice, data, and video are carried out. The modeling techniques for analyzing the interplay and technology and market relevance of xDSL, cable/coax, fiber, WiFi, WiMAX, and cellular wireless options are covered. The likely migration paths for these options towards the Next Generation Networks (NGNs) are mentioned.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 740
Telecommunication Networks: Requirements to Deployment
The ever-increasing customer demand for new and advanced services and the associated complexities of designing, deploying, optimizing, and managing telecom networks require advanced end to end technology and process expertise. This short course deals with the key concepts of requirements development, design processes, architecture finalization, system design, site testing, performance optimization, and network operations and management of current and upcoming Telecom networks. It provides an overview on how the process works from an idea or concept to productization and will give a view on associated complexities and challenges. Key advances in tools and techniques needed with these major steps are covered. Practical examples of the current and upcoming features which will make telecom networks competitive are addressed. Aspects of customer management, strategies for decision making, and the migration towards future networks are also addressed. Practical examples of networks of selected service providers and how they meet the local and global needs are mentioned.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 742
Digital System-on-Chip Design
This short course covers digital design techniques and hardware/software realization concepts in embedded computing systems using VHDL. Topics include: basics principles of VHDL programming; designing with FPGA; design of arithmetic logic unit; VHDL models for memories and busses; CPU design; system-on-chip design; efficient hardware realizations of FFT, DCT, and DWT.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 743
Signal and Data Compression with Embedded Systems
This short course deals with data compression techniques and hardware/software realization concepts in embedded computing systems. Key topics: fundamentals of random signal processing and information theory, compression and decompression processes, lossy and lossless compression methods, compression standards for video and audio, modeling and signal parameter estimation, transform techniques including FFT, DCT, and DWT. Hardware realizations of compression algorithms.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 744
Embedded Digital Systems for Time-Frequency Distribution, Signal Modeling, and Estimation
This short course deals with time-frequency distribution, signal modeling and estimation, and hardware/software realization concepts in embedded computing systems. Key topics include fundamentals of signal processing and random processes, short-time Fourier transform, split-spectrum processing, Gabor transform, Wigner distribution, Hilbert transform, wavelet transform, cosine transform, chirplet signal decomposition, matching pursuit, parametric time-series frequency estimation, hardware/software codesign and realizations of time-frequency distributions, and signal modeling algorithms.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 750
Synchrophasors for Power System Monitoring and Control
The course gives an introduction to synchrophasor technology from the perspective of power system monitoring and control. It discusses the fundamentals of measurements and synchrophasor estimation. It covers the IEEE Standard C37.118. Several synchrophasor estimation algorithms will be discussed as they relate to measurement and estimation errors. Various synchrophasor applications will be presented including situational awareness, event detection, model validation, oscillation detection, WAMS, and WAMPAC.
Prerequisite(s): [(ECE 419)]
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 752
Industrial Applications of Power Electronics and Motor Drives
Practical topologies of different types of power electronic converters are covered including industrial high-voltage and high-current applications, protection, and thermal management. Common industrial motor drives are examined with popular control techniques, simplified modeling, and worst-case design. Regulating and stabilizing methods are applied to switching power supplies, power conditioning systems, electronic ballasts, and electronic motors.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 755
Power System Protection
This course provides basic understanding of the role of protective relaying in the power system. It also delves into the needs of today's power systems for protection that is robust and tolerant to heavily loaded transmission systems. The students are challenged to be a part of the solution going forward including the role of wide area system protection.
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 756
Power System Maintenance Scheduling
This short course is aimed at providing an in-depth introduction to optimal generation and transmission maintenance in the regulated and restructured power systems. The basic principles of systems operation and economics related to maintenance scheduling will be discussed along with current practices and solution methods for the electric power industry.
Prerequisite(s): [(ECE 419 and ECE 420)]
Lecture: 2 **Lab:** 0 **Credits:** 2

ECE 764
Vehicular Power Systems
Conventional electrical power systems of land, sea, air, and space vehicles are detailed along with the scope for improvement. New electrical loads and advanced distribution system architectures of electric and hybrid electric vehicles are presented. Current trends in the vehicular industry, such as 42V automotive systems and more electric aircraft, are explained.
Lecture: 2 **Lab:** 0 **Credits:** 2

Master of Biomedical Imaging and Signals

The purpose of this degree program is to prepare students for leading edge positions in industry in the areas of biomedical imaging and signal processing. The professional Master of Biomedical Imaging and Signals is a course-only degree program that prepares students for professional practice.

The interdisciplinary nature of bioengineering generally involves many facets of electrical and computer engineering. The Department of Electrical and Computer Engineering offers several courses and research opportunities that engage students interested in biomedical engineering. In addition, there are a significant number of courses offered by the Department of Biomedical Engineering and other disciplines at the university which are of great importance to students interested in the professional master's degree in biomedical engineering, with specialization in medical imaging and bio-signals.

The admission requirements for the degree follow the existing admission requirements for other professional master's degrees in the ECE Department. Students whose accredited B.S. degree is not in electrical and computer engineering may pursue the professional master's degree provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to Illinois Institute of Technology's:

ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 218	Digital Systems	4
ECE 307	Electrodynamics	4
ECE 308	Signals and Systems	3
ECE 311	Engineering Electronics	4
BIOL 107	General Biology Lectures	3
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4
MATH 374	Probability and Statistics for Electrical and Computer Engineers	3

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

Students can pursue a professional master's degree in the area of biomedical imaging and signals by completing the required core and elective courses, including at least two ECE and one BME elective courses.

Curriculum

Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum Transfer Credit	9

Required Core Courses			(12)
ECE 481	Image Processing		3
or ECE 565	Computer Vision and Image Processing		
ECE 437	Digital Signal Processing I		3
or ECE 569	Digital Signal Processing II		
ECE 511	Analysis of Random Signals		3
BME 450	Animal Physiology		3
Imaging Elective Courses			(3)
Select a minimum of one course from the following:			3
ECE 507	Imaging Theory & Applications	3	
BME 532	Medical Imaging Science	3	
BME 535	Magnetic Resonance Imaging	3	
BME 537	Introduction to Molecular Imaging	3	
Signals Elective Courses			(6)
Select a minimum of two courses from the following:			6
ECE 505	Applied Optimization for Engineers	3	
ECE 566	Statistical Pattern Recognition	3	

ECE 567	Statistical Signal Processing	3
ECE 597	Special Problems	1-20
BME 501	Communication Skills in Biomedical Engineering	3
BME 551	Physiological Signal Processing and Control Theory	2
BME 552	Control Systems for Biomedical Engineers	3
General Electives		(9)
Select 9 credit hours of courses from ECE 400-799		9
Total Credit Hours		30

With adviser's approval, students may take up to two senior (400-level) or graduate level courses in engineering, math, or science.

Master of Electrical and Computer Engineering

The purpose of this degree is to prepare students for leading edge positions in industry in the fields of electrical and computer engineering. The Master of Electrical and Computer Engineering (M.E.C.E.) is a course-only degree program that prepares students for professional practice in electrical and computer engineering. The program can be completed in one year of full-time study.

The admission requirements for this degree follow the existing admission requirements for a master's degree in the ECE department. Students whose accredited B.S. degree is not in electrical engineering may pursue the M.E.C.E., provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to Illinois Institute of Technology's:

ECE 211 & ECE 213	Circuit Analysis I and Circuit Analysis II	7
ECE 218	Digital Systems	4
ECE 307	Electrodynamics	4
ECE 308	Signals and Systems	3
ECE 311	Engineering Electronics	4
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special departmental examinations administered by the department.

Curriculum

Students arrange their program of study with their adviser's approval and typically elect to build their program to emphasize one or more areas of specialization. No formal distribution requirements are imposed. Areas of specialization include communication systems, computer communication, computer engineering, power electronics, electromagnetics, electronics, VLSI and microelectronics, power systems, and signal and image processing.

Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum Transfer Credit	9
Minimum ECE Coursework	24
Maximum ECE Short Courses	6

Required Courses	(30)
Select 30 credit hours of courses from ECE 400-799	30
Total Credit Hours	30

Master of Electricity Markets

Restructuring of electricity delivery brings major changes to the electric power industry. Electricity is traded as a commodity in financial markets which affect the way electric power grids are controlled and operated. Today's electrical engineers are compelled to understand both the technical and business sides of such changes in order to address the needs of the electric power industry.

The Department of Electrical and Computer Engineering and the Stuart School of Business have teamed up to offer a master's degree in electricity markets. Combining courses from graduate programs in electrical engineering and in finance, the Master of Electricity Markets degree program provides graduate-level education in electricity suitable for electric power engineers. A background in finance is not required.

The admission requirements for this degree follow the existing admission requirements for other professional master's degrees in the ECE department. Students whose accredited B.S. degree is not in electrical engineering may pursue this degree, provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to Illinois Institute of Technology's:

ECE 211 & ECE 213	Circuit Analysis I and Circuit Analysis II	7
ECE 311	Engineering Electronics	4
ECE 319	Fundamentals of Power Engineering	4
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the ECE department.

Curriculum

Minimum Degree Credits	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum Transfer Credit	9

Required Core Courses			(15)
Select a minimum of five courses from the following:			15
ECE 417	Power Distribution Engineering	3	
ECE 418	Power System Analysis	3	
ECE 420	Analytical Methods in Power Systems	3	
ECE 553	Power System Planning	3	
ECE 555	Power Market Operations	3	
ECE 556	Power Market Economics and Security	3	
ECE 557	Fault-Tolerant Power Systems	3	
ECE 558	Power System Reliability	3	
ECE 561	Deregulated Power Systems	3	
ECE 562	Power System Transaction Management	3	
ECE 564	Control and Operation of Electric Power Systems	3	
ECE 580	Elements of Sustainable Energy	3	
ECE 581	Elements of Smart Grid	3	
ECE 582	Microgrid Design and Operation	3	
Finance Courses			(6)
Select a minimum of two courses from the following:			6
MSF 502	Statistical Analysis in Financial Markets [1]	3	
MSF 503	Financial Modeling [1]	3	
MSF 504	Valuation and Portfolio Management	3	
MSF 505	Futures, Options, and OTC Derivatives	3	
MSF 524	Models for Derivatives	3	
MSF 526	Computational Finance	3	

MSF 534	Corporate Finance	3	
MSF 554	Market Risk Management	3	
MSF 584	Equity and Equity Derivatives Trading	3	
General Electives			(9)
Select 9 credit hours of electives from ECE 400-799			9
Total Credit Hours			30

[1] A student can take MSF 502 or MSF 503, but only one can be counted toward the degree program.

Master of Network Engineering

The Master of Network Engineering (M.N.E.) is a course-only degree program that prepares students for professional practice in network engineering and information technologies. The M.N.E. is a focused professional master's degree requiring a minimum of 30 credit hours of adviser approved coursework. The program offered by the Department of Electrical and Computer Engineering (ECE) can be completed in one year of full-time study.

The admission requirements for this degree follow the existing admission requirements for master's degree in the ECE department. A person holding a B.S.E.E. or a B.S.CP.E. degree has the necessary background to undertake the M.N.E. program. A student without adequate background is required to demonstrate proficiency in the following courses:

ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 308	Signals and Systems	3
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4
MATH 474	Probability and Statistics	3

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

The M.N.E. program of study must include a minimum of 24 credit hours of ECE coursework, 12 credit hours of required core courses, 12 credit hours of M.N.E. elective courses, and 6 credit hours of adviser approved elective courses. At least 18 credit hours of the courses must be at the 500-level. A maximum of 6 credit hours may be taken from ECE 700-level short courses.

Curriculum

Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum Transfer Credit	9

Required Courses			(12-13)
ECE 511	Analysis of Random Signals		3
ECE 513	Communication Engineering Fundamentals		3
Select a minimum of one course from the following:			3-4
ECE 407	Introduction to Computer Networks with Laboratory	4	
ECE 408	Introduction to Computer Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 541	Performance Evaluation of Computer Networks		3
or ECE 542	Design and Optimization of Computer Networks		
Network Engineering Elective Courses			(12)
Select a minimum of 12 credit hours of 400- and 500-level courses below, approved by the faculty adviser: [1]			12
ECE 403	Digital and Data Communication Systems	3	
or ECE 405	Digital and Data Communication Systems with Laboratory		
ECE 406	Introduction to Wireless Communication Systems	3	
ECE 436	Digital Signal Processing I with Laboratory	4	
ECE 437	Digital Signal Processing I	3	
ECE 443	Introduction to Computer Security	4	

ECE 485	Computer Organization and Design	3	
ECE 504	Wireless Communication System Design	3	
ECE 508	Video Communications	3	
ECE 514	Digital Communication Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 516	Coding for Distributed Storage Systems	3	
ECE 519	Coding for Reliable Communications	3	
ECE 541	Performance Evaluation of Computer Networks	3	
ECE 542	Design and Optimization of Computer Networks	3	
ECE 543	Computer Network Security	3	
ECE 544	Wireless and Mobile Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 546	Wireless Network Security	3	
ECE 547	Wireless Networks Performance Analysis	3	
ECE 565	Computer Vision and Image Processing	3	
ECE 568	Digital Speech Processing	3	
ECE 569	Digital Signal Processing II	3	
ECE 570	Fiber-Optic Communication Systems	3	
ECE 583	High Speed Computer Arithmetic	3	
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3	
ECE 585	Advanced Computer Architecture	3	
CS 455	Data Communications	3	
CS 548	Broadband Networks	3	
Electives			(6)
Select 6 credit hours			6

[1] A maximum of 6 credit hours of ECE short courses can be included in the M.N.E. program of studies.

Master of Power Engineering

The purpose of this degree program is to prepare students for leading edge positions in industry in the areas of electric power, power electronics, motor drives, and electric machines. The professional Master of Power Engineering is a course-only degree program that prepares students for professional practice in power engineering.

The admission requirements for this degree follow the existing admission requirements for other professional master's degrees in the ECE department. Students whose accredited B.S. degree is not in electrical engineering may pursue the professional master's degree, provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to Illinois Institute of Technology's coursework:

ECE 211 & ECE 213	Circuit Analysis I and Circuit Analysis II	7
ECE 311	Engineering Electronics	4
ECE 319	Fundamentals of Power Engineering	4
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the ECE department.

Curriculum

Minimum Degree Credits	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum Transfer Credit	9

Core Courses			(13-14)
Select a minimum of three courses from the following:			10-11
ECE 411	Power Electronics	4	
ECE 412	Electric Motor Drives	4	
ECE 420	Analytical Methods in Power Systems	3	
ECE 551	Advanced Power Electronics	3	
ECE 418	Power System Analysis		3
or ECE 419	Power Systems Analysis with Laboratory		
Power Systems			(6)
Select a minimum of two courses from the following:			6
ECE 417	Power Distribution Engineering	3	
ECE 553	Power System Planning	3	
ECE 554	Power System Relaying	3	
ECE 555	Power Market Operations	3	
ECE 556	Power Market Economics and Security	3	
ECE 557	Fault-Tolerant Power Systems	3	
ECE 558	Power System Reliability	3	
ECE 559	High Voltage Power Transmission	3	
ECE 560	Power Systems Dynamics and Stability	3	
ECE 561	Deregulated Power Systems	3	
ECE 562	Power System Transaction Management	3	
ECE 563	Computational Intelligence in Engineering	3	
ECE 564	Control and Operation of Electric Power Systems	3	
ECE 580	Elements of Sustainable Energy	3	
ECE 581	Elements of Smart Grid	3	
ECE 582	Microgrid Design and Operation	3	
CHE 543	Energy, Environment, and Economics	3	
Power Electronics and Motor Drives			(6)

Select a minimum of two courses from the following:			6
ECE 437	Digital Signal Processing I	3	
ECE 438	Control Systems	3	
ECE 531	Linear System Theory	3	
ECE 533	Robust Control	3	
ECE 538	Renewable Energies	3	
ECE 539	Computer Aided Design of Electric Machines	3	
ECE 548	Energy Harvesting	3	
ECE 549	Motion Control Systems Dynamics	3	
ECE 550	Power Electronic Dynamics and Control	3	
ECE 552	Adjustable Speed Drives	3	
ECE 764	Vehicular Power Systems	2	
CHE 541	Renewable Energy Technologies	3	
General Electives			(4-5)
Select 4-5 credit hours			4-5

Up to 3 credit hours of a Graduate Special Project in power engineering (ECE 594 or ECE 597), and up to 6 credit hours of ECE short courses may be applied to the degree.

Master of Telecommunications and Software Engineering

Collaborative program with the Department of Computer Science

The Master of Telecommunications and Software Engineering (M.T.S.E.) is a course-only degree program that prepares students for professional practice in telecommunications and information technologies. The program, jointly offered by the Department of Electrical and Computer Engineering (ECE) and Department of Computer Science (CS), can be completed in one year of full-time study. The M.T.S.E. is a professional master's degree requiring a minimum of 30 credit hours of adviser-approved coursework.

Admission requirements for this degree follow the existing admission requirements for master's degrees in the ECE department. A person holding a B.S.E.E., a B.S.CP.E., or a B.S.C.S. degree has the necessary broad background to undertake the M.T.S.E. program. A student without adequate background in specific areas is required to demonstrate proficiency in prerequisite courses; an abbreviated course list is given below.

Specific proficiency courses will be detailed for each student at the time of admission to the M.T.S.E. program. A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

Prerequisites

Computer Science Prerequisites		(4)
CS 201	Accelerated Introduction to Computer Science [1]	4
Electrical and Computer Engineering Prerequisites		(21)
ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 308	Signals and Systems	3
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4
MATH 474	Probability and Statistics	3

1 i.e. CS 115 and CS 116 combined

Curriculum

Master of Telecommunications and Software Engineering, Computer Engineering Concentration

Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Minimum ECE Coursework	15

Minimum CS Coursework	12
Maximum ECE Short Courses	4
Maximum Transfer Credit	9

Required Courses			(15-16)
ECE 513	Communication Engineering Fundamentals		3
CS 586	Software Systems Architectures		3
CS 587	Software Project Management		3
Select a minimum of one course from the following:			3-4
ECE 407	Introduction to Computer Networks with Laboratory	4	
ECE 408	Introduction to Computer Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 541	Performance Evaluation of Computer Networks		3
or ECE 542	Design and Optimization of Computer Networks		
Software Engineering			(3)
Select a minimum of one course from the following:			3
CS 521	Object-Oriented Analysis and Design	3	
CS 537	Software Metrics	3	
CS 589	Software Testing and Analysis	3	
ECE 449	Object-Oriented Programming and Computer Simulation	3	
Telecommunication Systems			(3-4)
Select a minimum of one course from the following:			3-4
CS 544	Computer Networks II: Network Services	3	
CS 548	Broadband Networks	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
ECE 443	Introduction to Computer Security	4	
ECE 543	Computer Network Security	3	
ECE 544	Wireless and Mobile Networks	3	
ECE 546	Wireless Network Security	3	
ECE 547	Wireless Networks Performance Analysis	3	
Communications			(3)
Select a minimum of one course from the following:			3
ECE 504	Wireless Communication System Design	3	
ECE 508	Video Communications	3	
ECE 514	Digital Communication Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 519	Coding for Reliable Communications	3	
Elective Courses			(4-6)
Select the remaining credit hours of coursework from the courses listed above or other courses approved by the faculty adviser [1]			4-6

[1] Students without a background in communications or software engineering would be best prepared by including: CS 450, CS 455, CS 487, ECE 403, ECE 405, ECE 406.

Other recommended courses include:

CS 588	Advanced Software Engineering Development	3
ECE 436	Digital Signal Processing I with Laboratory	4
ECE 437	Digital Signal Processing I	3
ECE 511	Analysis of Random Signals	3
ECE 516	Coding for Distributed Storage Systems	3
ECE 520	Information Theory and Applications	3
ECE 565	Computer Vision and Image Processing	3
ECE 568	Digital Speech Processing	3

ECE 569	Digital Signal Processing II	3
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3

Master of VLSI and Microelectronics

The purpose of this degree program is to prepare students for leading edge positions in industry in the areas of VLSI and microelectronics. The professional Master of VLSI and Microelectronics is a course-only degree program that prepares students for professional practice.

The admission requirements for this degree follow the existing admission requirements for other professional master's degrees in the ECE department. Students whose accredited B.S. degree is not in electrical engineering may pursue the professional master's degree, provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to Illinois Institute of Technology's:

ECE 211 & ECE 213	Circuit Analysis I and Circuit Analysis II	7
ECE 218	Digital Systems	4
ECE 307	Electrodynamics	4
ECE 308	Signals and Systems	3
ECE 311	Engineering Electronics	4
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the ECE department.

Curriculum

Minimum Degree Credits	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum Transfer Credit	9

Core Courses			(16)
ECE 425	Analysis and Design of Integrated Circuits		3
ECE 429	Introduction to VLSI Design		4
ECE 430	Fundamentals of Semiconductor Devices		3
ECE 529	Advanced VLSI Systems Design		3
ECE 575	Electron Devices		3
Computer Engineering			(3-4)
Select a minimum of one course from the following:			3-4
ECE 429	Introduction to VLSI Design	4	
ECE 485	Computer Organization and Design	3	
ECE 529	Advanced VLSI Systems Design	3	
ECE 530	High Performance VLSI IC Systems	3	
ECE 542	Design and Optimization of Computer Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 583	High Speed Computer Arithmetic	3	
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3	
ECE 585	Advanced Computer Architecture	3	
ECE 586	Fault Detection in Digital Circuits	3	
ECE 587	Hardware/Software Codesign	3	
ECE 588	CAD Techniques for VLSI Design	3	
ECE 589	Computer-Aided Design of Analog IC	3	
Electronics			(3)
Select a minimum of one course from the following:			3
ECE 401	Communication Electronics	3	

ECE 425	Analysis and Design of Integrated Circuits	3
ECE 430	Fundamentals of Semiconductor Devices	3
ECE 521	Quantum Electronics	3
ECE 524	Advanced Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Performance Analysis of RF Integrated Circuits	3
ECE 551	Advanced Power Electronics	3
ECE 570	Fiber-Optic Communication Systems	3
ECE 571	Nanodevices and Technology	3
ECE 575	Electron Devices	3
ECE 578	Microwave Theory	3
General Electives		(12)
Select 12 credit hours of electives from ECE 400-799 [1]		12

[1] With adviser approval, the student may take up to two ECE courses in other areas of electrical and computer engineering, such as signal processing, communications, power and control.

Master of Science in Computer Engineering

The purpose of this degree is to prepare students for advanced study and/or research or industrial practice in the field of computer engineering. The Master of Science in Computer Engineering (M.S.CP.E.) program builds a strong foundation in all aspects of the design and development of computer systems, with a specialization in a major area. Students have the option to pursue thesis research under the guidance of a faculty adviser. Areas of study include computer hardware design, computer networking and telecommunications, and computer system and application software. The program is normally completed in three semesters of full-time study.

The admission requirements for this degree follow the existing admission requirements for master's degrees in the ECE department. Students whose accredited B.S. degree is not in computer engineering may pursue the M.S.CP.E., provided that they have an adequate background and can demonstrate proficiency in the material contained in the following undergraduate courses:

ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 218	Digital Systems	4
ECE 242	Digital Computers and Computing	3
or CS 350	Computer Organization and Assembly Language Programming	
ECE 311	Engineering Electronics	4
CS 201	Accelerated Introduction to Computer Science [1]	4
CS 401	Introduction to Advanced Studies I	3
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

[1] i.e. CS 115 and CS 116 combined

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

The program of study includes a minimum of 32 credit hours of acceptable graduate coursework, with a minimum of 21 credit hours of ECE coursework. A minimum of 20 credit hours must be taken at the 500-level or higher. Up to 6 credit hours of ECE short courses may be applied to the degree. Students, with adviser approval, select courses appropriate to their needs and interests. The program of study must include two core and two elective courses within one of the computer engineering (CPE) areas of concentration (computer hardware design, computer systems software, and networks and telecommunications), and at least one core course from the remaining two areas. An M.S.CP.E. candidate may, with permission of a thesis adviser, include in his or her program a thesis of 6-8 credit hours. The master's thesis is strongly recommended for pre-doctoral students. The thesis option requires a written thesis and an oral defense of the thesis. Thesis format and deadlines are set by the Graduate College.

Master of Science in Computer Engineering (Coursework Only Option)

Minimum Credits Required	32
Minimum ECE Course Credit	21
Maximum 400-Level Credit	12
Minimum 500-Level Credit	20
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Computer Engineering Major Courses	(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 118)	6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 118)	6-8
Computer Engineering Elective Courses	(6-8)
Select one core course from each of the two remaining CPE areas of concentration from the lists below (p. 118)	6-8
General Electives	(9-14)
Select 9-14 credit hours of general ECE electives	9-14

Master of Science in Computer Engineering (Thesis Option)

Minimum Credits Required	32
Minimum ECE Course Credit	21
Maximum 400-Level Credit	12
Minimum 500-Level Credit	20
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Computer Engineer Major Courses		(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 118)		6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 118)		6-8
Computer Engineering Elective Courses		(6-8)
Select one core course from each of the two remaining CPE areas of concentration from the lists below (p. 118)		6-8
General Electives		(1-8)
Select 1-8 credit hours of general ECE electives		1-8
Thesis Research		(6-8)
ECE 591	Research and Thesis for Masters Degree [1]	6-8

[1] Students pursuing the thesis option must complete 6-8 credit hours of research work (ECE 591) leading to an M.S. dissertation with the approval of a thesis adviser.

CPE Areas of Concentration

Computer Hardware Design

Core Courses		(6-7)
ECE 529	Advanced VLSI Systems Design	3-4
or ECE 429	Introduction to VLSI Design	
ECE 585	Advanced Computer Architecture	3
Elective Courses		(48)
ECE 425	Analysis and Design of Integrated Circuits	3
ECE 429	Introduction to VLSI Design	4
ECE 430	Fundamentals of Semiconductor Devices	3
ECE 441	Microcomputers	4
ECE 446	Advanced Logic Design	4
ECE 485	Computer Organization and Design	3
ECE 529	Advanced VLSI Systems Design	3
ECE 530	High Performance VLSI IC Systems	3
ECE 583	High Speed Computer Arithmetic	3

ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3
ECE 585	Advanced Computer Architecture	3
ECE 586	Fault Detection in Digital Circuits	3
ECE 587	Hardware/Software Codesign	3
ECE 588	CAD Techniques for VLSI Design	3
ECE 589	Computer-Aided Design of Analog IC	3

Computer Systems Software

Core Courses		(6)
CS 550	Advanced Operating Systems	3
CS 551	Operating System Design and Implementation	3
Elective Courses		(36)
ECE 449	Object-Oriented Programming and Computer Simulation	3
ECE 587	Hardware/Software Codesign	3
CS 487	Software Engineering I	3
CS 545	Distributed Computing Landscape	3
CS 546	Parallel and Distributed Processing	3
CS 550	Advanced Operating Systems	3
CS 551	Operating System Design and Implementation	3
CS 555	Analytic Models and Simulation of Computer Systems	3
CS 586	Software Systems Architectures	3
CS 587	Software Project Management	3
CS 588	Advanced Software Engineering Development	3
CS 589	Software Testing and Analysis	3

Networks and Telecommunications

Core Courses		(7)
ECE 407	Introduction to Computer Networks with Laboratory	4
or ECE 408	Introduction to Computer Networks	
ECE 541	Performance Evaluation of Computer Networks	3
or ECE 545	Advanced Computer Networks	
Elective Courses		(71)
ECE 407	Introduction to Computer Networks with Laboratory	4
ECE 408	Introduction to Computer Networks	3
ECE 443	Introduction to Computer Security	4
ECE 504	Wireless Communication System Design	3
ECE 508	Video Communications	3
ECE 511	Analysis of Random Signals	3
ECE 513	Communication Engineering Fundamentals	3
ECE 514	Digital Communication Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding for Distributed Storage Systems	3
ECE 519	Coding for Reliable Communications	3
ECE 520	Information Theory and Applications	3
ECE 541	Performance Evaluation of Computer Networks	3
ECE 542	Design and Optimization of Computer Networks	3
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 545	Advanced Computer Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Networks Performance Analysis	3
ECE 570	Fiber-Optic Communication Systems	3
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3

CS 455	Data Communications	3
CS 544	Computer Networks II: Network Services	3

Master of Science in Electrical Engineering

The purpose of this degree is to prepare students for advanced study and industry in the field of electrical engineering. The Master of Science in Electrical Engineering (M.S.E.E.) is a degree program combining breadth across several areas of study within electrical engineering and specialization within one area, which includes an option to pursue thesis research under the guidance of a faculty adviser. Areas of study include communication and signal processing, computers and microelectronics, and power and control systems. The program is normally completed in three semesters of full-time study.

The admission requirements for this degree follow the existing admission requirements for master's degrees in the ECE department. Students whose accredited B.S. degree is not in electrical engineering may pursue the M.S.E.E., provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to Illinois Institute of Technology's:

ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 218	Digital Systems	4
ECE 307	Electrodynamics	4
ECE 308	Signals and Systems	3
ECE 311	Engineering Electronics	4
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

A student may demonstrate proficiency by successfully completing the courses or by satisfactory performance in one or more special examinations administered by the department.

The program of study includes a minimum of 32 credit hours of acceptable graduate coursework, with a minimum of 20 credit hours of ECE courses at the 500-level or higher. Up to 6 credit hours of ECE short courses may be applied to the degree.

Students, with adviser approval, select courses appropriate to their needs and interests. The program of study must include a minimum of four courses within one of the electrical engineering (EE) areas of concentration and a minimum of two courses from the other areas. An M.S.E.E. candidate may, with permission of a thesis adviser, include in his or her program a thesis of 6-8 credit hours. The master's thesis is recommended for pre-doctoral students. The thesis option requires a written thesis and an oral defense of the thesis. Thesis format and deadlines are set by the Graduate College.

Master of Science in Electrical Engineering (Coursework Only Option)

Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level ECE Credit	20
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Electrical Engineering Major Courses	(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 121)	12-16
Electrical Engineering Minor Electives	(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 121)	6-8
General Electives	(10-14)
Select 10-14 credit hours of general ECE electives	10-14

Master of Science in Electrical Engineering (Thesis Option)

Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level ECE Credit	20
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Electrical Engineering Major Courses		(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 121)		12-16
Electrical Engineering Minor Electives		(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 121)		6-8
General Electives		(0-8)
Select 0-8 credit hours of general ECE electives		0-8
Thesis Research		(6-8)
ECE 591	Research and Thesis for Masters Degree [1]	6-8

[1] Students pursuing the thesis option must complete 6-8 credit hours of research work (ECE 591) leading to an M.S. dissertation with the approval of a thesis adviser.

EE Areas of Concentration

Communications and Signal Processing

ECE 401	Communication Electronics	3
ECE 403	Digital and Data Communication Systems	3
ECE 405	Digital and Data Communication Systems with Laboratory	4
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Circuits and Systems with Laboratory	4
ECE 436	Digital Signal Processing I with Laboratory	4
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 504	Wireless Communication System Design	3
ECE 507	Imaging Theory & Applications	3
ECE 508	Video Communications	3
ECE 509	Electromagnetic Field Theory	3
ECE 511	Analysis of Random Signals	3
ECE 513	Communication Engineering Fundamentals	3
ECE 514	Digital Communication Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding for Distributed Storage Systems	3
ECE 519	Coding for Reliable Communications	3
ECE 520	Information Theory and Applications	3
ECE 522	Electromagnetic Compatibility	3
ECE 565	Computer Vision and Image Processing	3
ECE 566	Statistical Pattern Recognition	3
ECE 567	Statistical Signal Processing	3
ECE 568	Digital Speech Processing	3
ECE 569	Digital Signal Processing II	3
ECE 570	Fiber-Optic Communication Systems	3
ECE 576	Antenna Theory	3
ECE 578	Microwave Theory	3

Computers and Microelectronics

ECE 407	Introduction to Computer Networks with Laboratory	4
ECE 408	Introduction to Computer Networks	3

ECE 425	Analysis and Design of Integrated Circuits	3
ECE 429	Introduction to VLSI Design	4
ECE 430	Fundamentals of Semiconductor Devices	3
ECE 441	Microcomputers	4
ECE 443	Introduction to Computer Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Object-Oriented Programming and Computer Simulation	3
ECE 485	Computer Organization and Design	3
ECE 502	Basic Network Theory	3
ECE 521	Quantum Electronics	3
ECE 524	Advanced Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Performance Analysis of RF Integrated Circuits	3
ECE 529	Advanced VLSI Systems Design	3
ECE 530	High Performance VLSI IC Systems	3
ECE 541	Performance Evaluation of Computer Networks	3
ECE 542	Design and Optimization of Computer Networks	3
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 545	Advanced Computer Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Networks Performance Analysis	3
ECE 571	Nanodevices and Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Computer Arithmetic	3
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3
ECE 585	Advanced Computer Architecture	3
ECE 586	Fault Detection in Digital Circuits	3
ECE 587	Hardware/Software Codesign	3
ECE 588	CAD Techniques for VLSI Design	3
ECE 589	Computer-Aided Design of Analog IC	3

Power and Control

ECE 411	Power Electronics	4
ECE 412	Electric Motor Drives	4
ECE 417	Power Distribution Engineering	3
ECE 418	Power System Analysis	3
ECE 419	Power Systems Analysis with Laboratory	4
ECE 420	Analytical Methods in Power Systems	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization for Engineers	3
ECE 506	Analysis of Nonlinear Systems	3
ECE 531	Linear System Theory	3
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 538	Renewable Energies	3
ECE 539	Computer Aided Design of Electric Machines	3
ECE 540	Reliability Theory and System Implementation	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Systems Dynamics	3
ECE 550	Power Electronic Dynamics and Control	3

ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Market Economics and Security	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3

Master of Science in Computer Engineering and Electrical Engineering

The purpose of the Master of Science in Computer Engineering and Electrical Engineering dual degree (M.S.CP.E/E.E.) is to prepare students for advanced study and/or research, or for industry in the fields of both computer and electrical engineering. The M.S.CP.E./E.E. program provides for a strong foundation in all aspects of the design and development of computer systems, and also offers several areas of study within electrical engineering. There is also an option to pursue thesis research under the guidance of a faculty adviser.

There is a growing need for engineers with a strong educational background in both computer engineering and electrical engineering. In the M.S.CP.E./E.E. program, students will be introduced to topics important to the computer engineering field, such as computer hardware design, computer networks, and software engineering, as well as topics in electrical engineering, such as communications and signal processing, electronics and electromagnetics, and power and control systems. The program of study includes a minimum of 45 credit hours of acceptable graduate coursework in both computer engineering and electrical engineering. M.S.CP.E./E.E. degree requirements are described in the section below. Requirements for the M.S.CP.E./E.E. fully satisfy the existing requirements for an M.S. in Computer Engineering and an M.S. in Electrical Engineering. The program is usually completed in four semesters of full-time study.

Admission requirements for the M.S.CP.E./E.E. are the same as those for admission to the Master of Science in Computer Engineering or Electrical Engineering. Students whose accredited B.S. degree is not in computer and/or electrical engineering may pursue the CP.E./E.E. degree provided that they demonstrate proficiency in the material contained in the following undergraduate courses:

ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 218	Digital Systems	4
ECE 242	Digital Computers and Computing	3
or CS 350	Computer Organization and Assembly Language Programming	
ECE 307	Electrodynamics	4
ECE 308	Signals and Systems	3
ECE 311	Engineering Electronics	4
CS 201	Accelerated Introduction to Computer Science [1]	4
CS 401	Introduction to Advanced Studies I	3
MATH 251	Multivariate and Vector Calculus	4
MATH 252	Introduction to Differential Equations	4

[1] i.e. CS 115 and CS 116 combined

A student may demonstrate proficiency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the department.

In addition to all university requirements for a master of science degree, the M.S.CP.E./E.E. degree has the following requirements:

1. A minimum of 45 credit hours of graduate-level coursework including the following:
   a. Two core courses and two elective courses in a CPE major area, chosen from among the CPE areas of concentration.
   b. One core course from each of the two remaining areas of CPE concentration.
   c. Four (or more) courses within an EE major area, chosen from among the EE areas of concentration (Areas I, II, and III).
   d. A minimum of two courses from two EE minor areas, chosen from among Areas I, II, and III outside the major.
   e. Additional coursework approved by the academic adviser.
2. A GPA of at least 3.0/4.0 (excluding prerequisites and proficiencies).

The CPE/EE program is subject to the following restrictions: a minimum of 30 credit hours coursework at the 500-level or higher; at least 30 credit hours of ECE courses, excluding short courses; no more than 6 credit hours of ECE short courses; 6-8 credit hours of research work (ECE 591) leading to an M.S. dissertation may be included with the approval of a thesis adviser.

Each regular (matriculated) graduate student is assigned an academic adviser, indicated in his/her formal letter of admission to the master's program.

Students should consult with their academic adviser to file a program of study meeting these requirements within three months after initial registration for full-time students, and prior to enrolling beyond 12 credit hours for part-time students.

Master of Science in Computer Engineering and Electrical Engineering (Coursework Only Option)

Minimum Credits Required	45
Minimum 500-Level Credit	30
Minimum ECE Credit	30
Maximum 700-Level Credit	6

Computer Engineering Major Courses	(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 125)	6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 125)	6-8
Computer Engineering Elective Courses	(6-8)
Select one course from each of the two remaining CPE areas of concentration from the lists below (p. 125)	6-8
Electrical Engineering Major Courses	(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 126)	12-16
Electrical Engineering Minor Electives	(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 126)	6-8
General Electives	(0-9)
Select 0-9 credit hours of general ECE electives	0-9

Master of Science in Computer Engineering and Electrical Engineering (Thesis Option)

Minimum Credits Required	45
Minimum 500-Level Credit	30
Minimum ECE Credit	30
Maximum 700-Level Credit	6

Computer Engineering Major Courses		(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 125)		6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 125)		6-8
Computer Engineering Elective Courses		(6-8)
Select one course from each of the two remaining CPE areas of concentration from the lists below (p. 125)		6-8
Electrical Engineering Major Courses		(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 126)		12-16
Electrical Engineering Minor Electives		(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 126)		6-8
General Electives		(0-3)
Select 0-3 credit hours of general ECE electives		0-3
Thesis Research		(6-8)
ECE 591	Research and Thesis for Masters Degree	6-8

[1] Students pursuing the thesis option must complete 6-8 credit hours of research work (ECE 591) leading to an M.S. dissertation with the approval of a thesis adviser.

CPE Areas of Concentration

Computer Hardware Design

Core Courses		(6-7)
ECE 529	Advanced VLSI Systems Design	3-4
or ECE 429	Introduction to VLSI Design	
ECE 585	Advanced Computer Architecture	3
Elective Courses		(48)
ECE 425	Analysis and Design of Integrated Circuits	3
ECE 429	Introduction to VLSI Design	4
ECE 430	Fundamentals of Semiconductor Devices	3
ECE 441	Microcomputers	4
ECE 446	Advanced Logic Design	4
ECE 485	Computer Organization and Design	3
ECE 529	Advanced VLSI Systems Design	3
ECE 530	High Performance VLSI IC Systems	3
ECE 583	High Speed Computer Arithmetic	3
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3
ECE 585	Advanced Computer Architecture	3
ECE 586	Fault Detection in Digital Circuits	3
ECE 587	Hardware/Software Codesign	3
ECE 588	CAD Techniques for VLSI Design	3
ECE 589	Computer-Aided Design of Analog IC	3

Computer Systems Software

Core Courses		(6)
CS 550	Advanced Operating Systems	3
CS 551	Operating System Design and Implementation	3
Elective Courses		(36)

ECE 449	Object-Oriented Programming and Computer Simulation	3
ECE 587	Hardware/Software Codesign	3
CS 487	Software Engineering I	3
CS 545	Distributed Computing Landscape	3
CS 546	Parallel and Distributed Processing	3
CS 550	Advanced Operating Systems	3
CS 551	Operating System Design and Implementation	3
CS 555	Analytic Models and Simulation of Computer Systems	3
CS 586	Software Systems Architectures	3
CS 587	Software Project Management	3
CS 588	Advanced Software Engineering Development	3
CS 589	Software Testing and Analysis	3

Networks and Telecommunications

Core Courses		(7)
ECE 407	Introduction to Computer Networks with Laboratory	4
or ECE 408	Introduction to Computer Networks	
ECE 541	Performance Evaluation of Computer Networks	3
or ECE 545	Advanced Computer Networks	
Elective Courses		(71)
ECE 407	Introduction to Computer Networks with Laboratory	4
ECE 408	Introduction to Computer Networks	3
ECE 443	Introduction to Computer Security	4
ECE 504	Wireless Communication System Design	3
ECE 508	Video Communications	3
ECE 511	Analysis of Random Signals	3
ECE 513	Communication Engineering Fundamentals	3
ECE 514	Digital Communication Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding for Distributed Storage Systems	3
ECE 519	Coding for Reliable Communications	3
ECE 520	Information Theory and Applications	3
ECE 541	Performance Evaluation of Computer Networks	3
ECE 542	Design and Optimization of Computer Networks	3
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 545	Advanced Computer Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Networks Performance Analysis	3
ECE 570	Fiber-Optic Communication Systems	3
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3
CS 455	Data Communications	3
CS 544	Computer Networks II: Network Services	3

EE Areas of Concentration

Communications and Signal Processing

ECE 401	Communication Electronics	3
ECE 403	Digital and Data Communication Systems	3
ECE 405	Digital and Data Communication Systems with Laboratory	4
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Circuits and Systems with Laboratory	4
ECE 436	Digital Signal Processing I with Laboratory	4

ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 504	Wireless Communication System Design	3
ECE 507	Imaging Theory & Applications	3
ECE 508	Video Communications	3
ECE 509	Electromagnetic Field Theory	3
ECE 511	Analysis of Random Signals	3
ECE 513	Communication Engineering Fundamentals	3
ECE 514	Digital Communication Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding for Distributed Storage Systems	3
ECE 519	Coding for Reliable Communications	3
ECE 520	Information Theory and Applications	3
ECE 522	Electromagnetic Compatibility	3
ECE 565	Computer Vision and Image Processing	3
ECE 566	Statistical Pattern Recognition	3
ECE 567	Statistical Signal Processing	3
ECE 568	Digital Speech Processing	3
ECE 569	Digital Signal Processing II	3
ECE 570	Fiber-Optic Communication Systems	3
ECE 576	Antenna Theory	3
ECE 578	Microwave Theory	3

Computers and Microelectronics

ECE 407	Introduction to Computer Networks with Laboratory	4
ECE 408	Introduction to Computer Networks	3
ECE 425	Analysis and Design of Integrated Circuits	3
ECE 429	Introduction to VLSI Design	4
ECE 430	Fundamentals of Semiconductor Devices	3
ECE 441	Microcomputers	4
ECE 443	Introduction to Computer Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Object-Oriented Programming and Computer Simulation	3
ECE 485	Computer Organization and Design	3
ECE 502	Basic Network Theory	3
ECE 521	Quantum Electronics	3
ECE 524	Advanced Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Performance Analysis of RF Integrated Circuits	3
ECE 529	Advanced VLSI Systems Design	3
ECE 530	High Performance VLSI IC Systems	3
ECE 541	Performance Evaluation of Computer Networks	3
ECE 542	Design and Optimization of Computer Networks	3
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 545	Advanced Computer Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Networks Performance Analysis	3
ECE 571	Nanodevices and Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Computer Arithmetic	3

ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3
ECE 585	Advanced Computer Architecture	3
ECE 586	Fault Detection in Digital Circuits	3
ECE 587	Hardware/Software Codesign	3
ECE 588	CAD Techniques for VLSI Design	3
ECE 589	Computer-Aided Design of Analog IC	3

Power and Control

ECE 411	Power Electronics	4
ECE 412	Electric Motor Drives	4
ECE 417	Power Distribution Engineering	3
ECE 418	Power System Analysis	3
ECE 419	Power Systems Analysis with Laboratory	4
ECE 420	Analytical Methods in Power Systems	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization for Engineers	3
ECE 506	Analysis of Nonlinear Systems	3
ECE 531	Linear System Theory	3
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 538	Renewable Energies	3
ECE 539	Computer Aided Design of Electric Machines	3
ECE 540	Reliability Theory and System Implementation	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Systems Dynamics	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Market Economics and Security	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3

Doctor of Philosophy in Computer Engineering

The doctoral degree in computer engineering is awarded in recognition of mastery in the field of computer engineering and upon demonstrating the ability to make fundamental contributions to knowledge in that field. The Ph.D. recipient will be capable of making a continuing effort toward the advancement of knowledge and achievement in research and other scholarly activities. This program is appropriate for those students with a master's degree in computer and/or electrical engineering who are interested in pursuing an academic or industrial research career.

The Ph.D. program requires a minimum of 72 credit hours beyond the bachelor's degree, including the master's degree studies. A minimum of 24 credit hours are devoted to the student's research work, and a minimum of 15 credit hours are devoted to coursework in computer and electrical engineering and in basic sciences, such as computers, mathematics, and physics. The selection of courses is considered and approved by the student's adviser and the department's graduate program director on the basis of relevance of course content, rather than along a predetermined sequence announced by the department.

Generally, it takes a minimum of three years of study beyond the master's degree to obtain a Ph.D.

Upon admission to graduate study leading to the Ph.D. degree, each student is assigned an academic adviser, who many eventually serve as the thesis adviser and guide the student's research. The department requires a qualifying examination within the first three semesters of full-time Ph.D. study. This is a written examination covering topics in the area of digital and computer systems and at least one minor area in the field of electrical engineering. This examination is intended to explore both the depth and breadth of the student's academic abilities.

At an early stage in the student's research program, and usually about a year after passing the qualifying examination, a comprehensive examination is held in the area of specialization. The comprehensive examination takes the form of a defense of a thesis research proposal. At this time a thesis committee is appointed by the graduate program director, in consultation with the thesis adviser, to guide the remainder of the program. A written dissertation, oral defense, and publication requirement constitute completion of the Ph.D. degree. The defense takes place no earlier than one year after passing the comprehensive examination. Dissertation format and deadlines are established by the Graduate College.

Curriculum

Minimum Degree Credits	72
Maximum 400-Level Credit	12
Minimum 500-Level Credit	15
Maximum 700-Level Credit	6
Maximum Transfer Credit	36

Ph.D. Research		(24-25)
ECE 691	Research and Thesis for Ph.D.	24-25
Transfer		(0-36)
Transfer up to 36 credit hours		0-36
General Electives		(15-48)
Select 15-48 credit hours of electives from ECE 400-599, ECE 601-699, and ECE 700-799 to fulfill minimum total credits		15-48

Doctor of Philosophy in Electrical Engineering

The doctoral degree in electrical engineering is awarded in recognition of mastery in the field of electrical engineering and upon demonstration of an ability to make substantial creative contributions to knowledge in that field. The Ph.D. recipient will be capable of a continuing effort toward the advancement of knowledge and achievement in research and other scholarly activities. This program is appropriate for those students with master's degrees who are interested in pursuing an academic or industrial research career.

The Ph.D. program requires a minimum of 72 credit hours beyond the bachelor's degree, including the master's degree studies. A minimum of 24 credit hours are devoted to the student's research work, and a minimum of 15 credit hours are devoted to coursework in electrical and computer engineering and in such basic sciences as mathematics and physics. The selection of courses is considered and approved by the student's adviser and the department's graduate program director on the basis of relevance of course content, rather than along a predetermined sequence announced by the department.

Work toward the Ph.D. generally takes a minimum of three years of study beyond the master's degree. Upon admission to graduate study leading to the Ph.D. degree, each student is assigned an academic adviser, who may eventually serve as the thesis adviser and guide the student's research.

The department requires a qualifying examination within the first three semesters of full-time Ph.D. studies. This is a written examination covering several areas in electrical and computer engineering. This examination is intended to explore both the depth and breadth of the student's academic abilities. At an early stage in the student's research program, and usually about a year after passing the qualifying examination, a comprehensive examination is held in the area of specialization.

The comprehensive examination takes the form of an oral presentation and defense of a thesis research proposal. At this time a thesis committee is appointed by the graduate program director, in consultation with the thesis adviser, to guide the remainder of the program. A written dissertation, oral defense, and publication requirement constitute completion of the Ph.D. degree. The defense takes place no earlier than one year after passing the comprehensive examination. Dissertation format and deadlines are established by the Graduate College.

Curriculum

Minimum Degree Credits	72
Maximum 400-Level Credit	12
Minimum 500-Level Credit	15
Maximum 700-Level Credit	6
Maximum Transfer Credit	36

Ph.D. Research		(24-25)
ECE 691	Research and Thesis for Ph.D.	24-25
Transfer		(0-36)
Transfer up to 36 credit hours		0-36
General Electives		(15-48)
Select 15-48 credit hours of electives from ECE 400-599, ECE 601-699, and ECE 700-799 to fulfill minimum total credits		15-48

Master of Electrical and Computer Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum 700-Level Credit	6
Minimum ECE Credit	24
Maximum Transfer Credit	9

Code	Title		Credit Hours
E3 Courses			(12)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of two courses from Group A			6
Select a minimum of one course from Group B			3
Power & Control Courses			(6-8)
Select a minimum of two courses from the following:			6-8
ECE 411	Power Electronics	4	
ECE 412	Electric Motor Drives	4	
ECE 417	Power Distribution Engineering	3	
ECE 419	Power Systems Analysis with Laboratory	4	
ECE 420	Analytical Methods in Power Systems	3	
ECE 438	Control Systems	3	
ECE 505	Applied Optimization for Engineers	3	
ECE 506	Analysis of Nonlinear Systems	3	
ECE 531	Linear System Theory	3	
ECE 535	Discrete Time Systems	3	
ECE 538	Renewable Energies	3	
ECE 539	Computer Aided Design of Electric Machines	3	
ECE 540	Reliability Theory and System Implementation	3	

ECE 548	Energy Harvesting	3
ECE 549	Motion Control Systems Dynamics	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Market Economics and Security	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3
Master's Project		(3-6)
Select 3-6 credit hours [1]		3-6
General Electives		(6-11)
Select 6-11 credit hours of electives from ECE 400-599, ECE 601-699, and ECE 700-799		6-11

[1] ECE 594 or ECE 597

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3

MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Science in Electrical Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Code	Title		Credit Hours
E3 Courses			(12)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of two courses from Group A			6
Select a minimum of one course from Group B			3
Power & Control Courses			(6-8)
Select a minimum of two courses from the following:			6-8
ECE 411	Power Electronics	4	
ECE 412	Electric Motor Drives	4	
ECE 417	Power Distribution Engineering	3	
ECE 419	Power Systems Analysis with Laboratory	4	
ECE 420	Analytical Methods in Power Systems	3	
ECE 438	Control Systems	3	
ECE 505	Applied Optimization for Engineers	3	
ECE 506	Analysis of Nonlinear Systems	3	
ECE 531	Linear System Theory	3	
ECE 535	Discrete Time Systems	3	
ECE 538	Renewable Energies	3	
ECE 539	Computer Aided Design of Electric Machines	3	
ECE 540	Reliability Theory and System Implementation	3	

ECE 548	Energy Harvesting	3	
ECE 549	Motion Control Systems Dynamics	3	
ECE 550	Power Electronic Dynamics and Control	3	
ECE 551	Advanced Power Electronics	3	
ECE 552	Adjustable Speed Drives	3	
ECE 553	Power System Planning	3	
ECE 554	Power System Relaying	3	
ECE 555	Power Market Operations	3	
ECE 556	Power Market Economics and Security	3	
ECE 557	Fault-Tolerant Power Systems	3	
ECE 558	Power System Reliability	3	
ECE 559	High Voltage Power Transmission	3	
ECE 560	Power Systems Dynamics and Stability	3	
ECE 561	Deregulated Power Systems	3	
ECE 562	Power System Transaction Management	3	
ECE 563	Computational Intelligence in Engineering	3	
ECE 564	Control and Operation of Electric Power Systems	3	
ECE 580	Elements of Sustainable Energy	3	
ECE 581	Elements of Smart Grid	3	
ECE 582	Microgrid Design and Operation	3	
Communications & Signal Processing			(3-4)
Select a minimum of one course from the following:			3-4
ECE 401	Communication Electronics	3	
ECE 403	Digital and Data Communication Systems	3	
ECE 405	Digital and Data Communication Systems with Laboratory	4	
ECE 421	Microwave Circuits and Systems	3	
ECE 423	Microwave Circuits and Systems with Laboratory	4	
ECE 436	Digital Signal Processing I with Laboratory	4	
ECE 437	Digital Signal Processing I	3	
ECE 481	Image Processing	3	
ECE 504	Wireless Communication System Design	3	
ECE 507	Imaging Theory & Applications	3	
ECE 508	Video Communications	3	
ECE 509	Electromagnetic Field Theory	3	
ECE 511	Analysis of Random Signals	3	
ECE 513	Communication Engineering Fundamentals	3	
ECE 514	Digital Communication Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 516	Coding for Distributed Storage Systems	3	
ECE 519	Coding for Reliable Communications	3	
ECE 522	Electromagnetic Compatibility	3	
ECE 565	Computer Vision and Image Processing	3	
ECE 566	Statistical Pattern Recognition	3	
ECE 567	Statistical Signal Processing	3	
ECE 568	Digital Speech Processing	3	
ECE 569	Digital Signal Processing II	3	
ECE 570	Fiber-Optic Communication Systems	3	
ECE 576	Antenna Theory	3	
ECE 578	Microwave Theory	3	
Computer & Microelectronics			(3-4)
Select a minimum of one course from the following:			3-4
ECE 407	Introduction to Computer Networks with Laboratory	4	

ECE 408	Introduction to Computer Networks	3
ECE 425	Analysis and Design of Integrated Circuits	3
ECE 429	Introduction to VLSI Design	4
ECE 441	Microcomputers	4
ECE 443	Introduction to Computer Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Object-Oriented Programming and Computer Simulation	3
ECE 485	Computer Organization and Design	3
ECE 502	Basic Network Theory	3
ECE 521	Quantum Electronics	3
ECE 524	Advanced Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Performance Analysis of RF Integrated Circuits	3
ECE 529	Advanced VLSI Systems Design	3
ECE 530	High Performance VLSI IC Systems	3
ECE 541	Performance Evaluation of Computer Networks	3
ECE 542	Design and Optimization of Computer Networks	3
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 545	Advanced Computer Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Networks Performance Analysis	3
ECE 571	Nanodevices and Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Computer Arithmetic	3
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3
ECE 585	Advanced Computer Architecture	3
ECE 586	Fault Detection in Digital Circuits	3
ECE 587	Hardware/Software Codesign	3
ECE 588	CAD Techniques for VLSI Design	3
ECE 589	Computer-Aided Design of Analog IC	3
Master's Thesis Research		(6-8)
ECE 591	Research and Thesis for Masters Degree [1]	6-8
General Electives		(0-2)
Select 0-2 credit hours of ECE 400-599, ECE 600-699, and ECE 700-799 [2]		0-2

[1] Thesis research topic must be in an interdisciplinary E3 area.

[2] Students should choose one advanced math course if that requirement was not met in the B.S. degree.

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3

ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Doctor of Philosophy in Electrical Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Requirement	Credits
Minimum Credits Required	72
Minimum 500+-level ECE Course Credits	15
Maximum Transfer Credit	32

Code	Title	Credit Hours
E3 Courses		(18)
CHE 543	Energy, Environment, and Economics	3
Select a minimum of five courses from Groups A and B		15
Ph.D. Research		(24-36)
ECE 691	Research and Thesis for Ph.D. [1]	24-36

[1] Dissertation research topic must be in an interdisciplinary E3 area.

Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one professor with specialization in an energy and sustainability area from outside the student's department.

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Certificate in Advanced Electronics

This program is composed entirely of elective courses and provides advanced study in electronic design and device theory for those who wish to enhance their analog and digital design skills, while increasing their knowledge of the underlying device physics.

Curriculum

A maximum of two 400-level courses may be taken.

Elective Courses			(12-13)
Select a minimum of four courses from the following:			12-13
ECE 411	Power Electronics	4	
ECE 425	Analysis and Design of Integrated Circuits	3	
ECE 430	Fundamentals of Semiconductor Devices	3	
ECE 521	Quantum Electronics	3	
ECE 524	Advanced Electronic Circuit Design	3	
ECE 525	RF Integrated Circuit Design	3	
ECE 526	Active Filter Design	3	
ECE 527	Performance Analysis of RF Integrated Circuits	3	
ECE 529	Advanced VLSI Systems Design	3	
ECE 530	High Performance VLSI IC Systems	3	
ECE 571	Nanodevices and Technology	3	
ECE 575	Electron Devices	3	
Total Credit Hours			12-13

Certificate in Applied Electromagnetics

In this certificate program, students receive advanced preparation for careers in electromagnetic engineering, particularly in areas of RF circuits and systems, electromagnetic wave propagation, antenna theory, and electromagnetic compatibility.

Curriculum

Required Courses			(6-7)
ECE 509	Electromagnetic Field Theory		3
ECE 421	Microwave Circuits and Systems		3-4
or ECE 423	Microwave Circuits and Systems with Laboratory		
Elective Courses			(6)
Select a minimum of two courses from the following:			6
ECE 522	Electromagnetic Compatibility	3	
ECE 571	Nanodevices and Technology	3	
ECE 576	Antenna Theory	3	
ECE 578	Microwave Theory	3	
Total Credit Hours			12-13

Certificate in Communication Systems

This certificate program is for those who want to become proficient in communication system principles and applications. The student will take the two fundamental courses and two courses from a large number of electives, for emphasis in data compression, computer networks, and analog/digital communications.

Curriculum

No more than one course may be a 400-level course.

Required Courses			(6)
ECE 511	Analysis of Random Signals		3
ECE 513	Communication Engineering Fundamentals		3
Elective Courses			(6-7)
Select a minimum of two courses from the following:			6-7
ECE 405	Digital and Data Communication Systems with Laboratory	4	
ECE 508	Video Communications	3	
ECE 514	Digital Communication Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 516	Coding for Distributed Storage Systems	3	
ECE 519	Coding for Reliable Communications	3	
ECE 520	Information Theory and Applications	3	
ECE 541	Performance Evaluation of Computer Networks	3	
ECE 542	Design and Optimization of Computer Networks	3	
ECE 543	Computer Network Security	3	
ECE 544	Wireless and Mobile Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 546	Wireless Network Security	3	
ECE 547	Wireless Networks Performance Analysis	3	
Total Credit Hours			12-13

Certificate in Computer Engineering

Graduates of this program gain proficiency in one of several areas, including VLSI design, computer networks, computer hardware, and software design.

Curriculum

A maximum of one 400-level course may be taken, including ECE 429 if selected as a required course.

Required Courses			(6-7)
ECE 585	Advanced Computer Architecture		3
ECE 429	Introduction to VLSI Design		3-4
or ECE 529	Advanced VLSI Systems Design		
Elective Courses			(6-8)
Select a minimum of two courses from the following:			6-8
ECE 430	Fundamentals of Semiconductor Devices	3	
ECE 441	Microcomputers	4	
ECE 443	Introduction to Computer Security	4	
ECE 446	Advanced Logic Design	4	
ECE 449	Object-Oriented Programming and Computer Simulation	3	
ECE 485	Computer Organization and Design	3	
ECE 530	High Performance VLSI IC Systems	3	
ECE 541	Performance Evaluation of Computer Networks	3	
ECE 542	Design and Optimization of Computer Networks	3	
ECE 543	Computer Network Security	3	

ECE 544	Wireless and Mobile Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 546	Wireless Network Security	3	
ECE 547	Wireless Networks Performance Analysis	3	
ECE 583	High Speed Computer Arithmetic	3	
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3	
ECE 586	Fault Detection in Digital Circuits	3	
ECE 587	Hardware/Software Codesign	3	
ECE 588	CAD Techniques for VLSI Design	3	
ECE 589	Computer-Aided Design of Analog IC	3	
Total Credit Hours			12-15

Certificate in Control Systems

Engineers who deal with the control and optimization of systems will benefit from the focused coursework in this program, providing intensive studies in linear and non-linear systems, optimized control, controlability and stability of systems, and analysis and synthesis of control systems.

Curriculum

Required Courses			(6)
ECE 531	Linear System Theory		3
ECE 535	Discrete Time Systems		3
Elective Courses			(6)
Select a minimum of two courses from the following:			6
ECE 438	Control Systems	3	
or ECE 506	Analysis of Nonlinear Systems		
ECE 533	Robust Control	3	
ECE 550	Power Electronic Dynamics and Control	3	
Total Credit Hours			12

Certificate in Electricity Markets

This program is an introduction to both the technical and business sides of a deregulated electric power industry.

Curriculum

Power System Courses			(6)
Select a minimum of two courses from the following:			6
ECE 555	Power Market Operations	3	
ECE 556	Power Market Economics and Security	3	
ECE 561	Deregulated Power Systems	3	
ECE 562	Power System Transaction Management	3	
Finance Courses			(6)
Select a minimum of two courses from the following:			6
MSF 504	Valuation and Portfolio Management	3	
MSF 505	Futures, Options, and OTC Derivatives	3	
MSF 554	Market Risk Management	3	
MSF 584	Equity and Equity Derivatives Trading	3	
Total Credit Hours			12

Certificate in Power Electronics

In this certificate program, students receive professional preparation in the areas of power electronic converters, industrial electronics, switching power supplies, electric/electronic motor drives, and electric power quality. This certificate program is useful to managers, engineers, and students who are seeking a position in power electronics related industry.

Curriculum

Required Courses			(6-7)
Select a minimum of two courses from the following:			6-7
ECE 411	Power Electronics	4	
ECE 550	Power Electronic Dynamics and Control	3	
ECE 551	Advanced Power Electronics	3	
ECE 552	Adjustable Speed Drives	3	
Elective Courses			(6)
Select a minimum of two courses from the following:			6
ECE 437	Digital Signal Processing I	3	
ECE 438	Control Systems	3	
ECE 531	Linear System Theory	3	
ECE 533	Robust Control	3	
ECE 535	Discrete Time Systems	3	
ECE 538	Renewable Energies	3	
ECE 539	Computer Aided Design of Electric Machines	3	
ECE 548	Energy Harvesting	3	
ECE 575	Electron Devices	3	
Total Credit Hours			12-13

Certificate in Power Engineering

This program provides power engineers with a solid foundation in the design and analysis of large-scale power systems and state-of-the-art power conversion systems, including power systems control, power electronics, motor drives, design of fault-tolerant systems, power markets, and fundamentals of power system operation and planning.

Curriculum

Required Courses			(6-8)
Select a minimum of two courses from the following:			6-8
ECE 411	Power Electronics	4	
ECE 412	Electric Motor Drives	4	
ECE 418	Power System Analysis	3	
ECE 419	Power Systems Analysis with Laboratory	4	
ECE 420	Analytical Methods in Power Systems	3	
Elective Courses			(9)
Select a minimum of three courses from the following:			9
ECE 417	Power Distribution Engineering	3	
ECE 533	Robust Control	3	
ECE 538	Renewable Energies	3	
ECE 539	Computer Aided Design of Electric Machines	3	
ECE 540	Reliability Theory and System Implementation	3	
ECE 548	Energy Harvesting	3	
ECE 549	Motion Control Systems Dynamics	3	
ECE 550	Power Electronic Dynamics and Control	3	
ECE 551	Advanced Power Electronics	3	
ECE 552	Adjustable Speed Drives	3	
ECE 553	Power System Planning	3	

ECE 554	Power System Relaying	3	
ECE 555	Power Market Operations	3	
ECE 556	Power Market Economics and Security	3	
ECE 557	Fault-Tolerant Power Systems	3	
ECE 558	Power System Reliability	3	
ECE 559	High Voltage Power Transmission	3	
ECE 560	Power Systems Dynamics and Stability	3	
ECE 561	Deregulated Power Systems	3	
ECE 562	Power System Transaction Management	3	
ECE 563	Computational Intelligence in Engineering	3	
ECE 564	Control and Operation of Electric Power Systems	3	
ECE 580	Elements of Sustainable Energy	3	
ECE 581	Elements of Smart Grid	3	
ECE 582	Microgrid Design and Operation	3	
Total Credit Hours			15-17

Certificate in Signal Processing

Those seeking expertise in the areas of signal and image processing should take this program, which offers a wide range of advanced courses in the areas of digital signal processing, data compression, image and speech processing, and pattern recognition.

Curriculum

Required Courses			(6)
ECE 511	Analysis of Random Signals		3
ECE 569	Digital Signal Processing II		3
Elective Courses			(6-7)
Select a minimum of two courses from the following: [1]			6-7
ECE 436	Digital Signal Processing I with Laboratory	4	
ECE 437	Digital Signal Processing I	3	
ECE 481	Image Processing	3	
ECE 507	Imaging Theory & Applications	3	
ECE 508	Video Communications	3	
ECE 565	Computer Vision and Image Processing	3	
ECE 566	Statistical Pattern Recognition	3	
ECE 567	Statistical Signal Processing	3	
ECE 568	Digital Speech Processing	3	
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3	
Total Credit Hours			12-13

[1] No more than one selection may be a 400-level course.

Certificate in Wireless Communications Engineering

For communications engineers who want a focused program providing state-of-the-art instruction in the growing field of wireless communications, this program offers fundamental coursework in traditional telecommunications system design as well as computer communication networks.

Curriculum

Required Courses			(6)
ECE 504	Wireless Communication System Design		3
ECE 513	Communication Engineering Fundamentals		3
Elective Courses			(6)
Select a minimum of two courses from the following:			6
ECE 514	Digital Communication Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 516	Coding for Distributed Storage Systems	3	
ECE 519	Coding for Reliable Communications	3	
ECE 520	Information Theory and Applications	3	
ECE 544	Wireless and Mobile Networks	3	
ECE 546	Wireless Network Security	3	
ECE 547	Wireless Networks Performance Analysis	3	
ECE 576	Antenna Theory	3	
Total Credit Hours			12

Mechanical, Materials, and Aerospace Engineering

243 John T. Rettaliata Engineering Center
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312.567.3175
mmae@iit.edu
engineering.iit.edu/mmae/

Interim Chair
Sumanta Acharya

Faculty with Research Interests
For more information regarding faculty visit the Department of Mechanical, Materials, and Aerospace Engineering website.

The Department of Mechanical, Materials, and Aerospace Engineering offers several flexible programs in mechanical and aerospace engineering, with five major areas of study: computer-aided design and manufacturing, dynamics and control, fluid dynamics, solids and structures, and thermal sciences. The department also offers programs in materials science and engineering and manufacturing engineering.

Research Centers

Fluid Dynamics Research Center
Thermal Processing Technology Center

Research Facilities

Mechanical and aerospace engineering laboratories include the Fejer Unsteady Wind Tunnel; the Morkovin Low-Turbulence Wind Tunnel; the National Diagnostic Facility, a computer-controlled, high-speed, subsonic flow wind tunnel; a high-speed jet facility for aeroacoustic research; a hydrodynamics laboratory; flow visualization systems; laser-based measuring equipment and manufacturing; several computer-based data acquisition, processing and display systems of the Fluid Dynamics Research Center; laboratories in experimental mechanics; laboratories for research in robotics, guidance and navigation, computer integrated manufacturing, Footlik CAD lab, biomechanics and its instrumentation, combustion, and internal combustion engines.

Materials science and engineering laboratories include facilities for research in metallography, heat treatment, and mechanical testing; optical, scanning, and transmission electron microscopes; powder metallurgy, and laser machining facilities. The department has numerous computers and workstations available for computational research activities.

Research Areas

The faculty conducts research activities in fluid dynamics, including aeroacoustics, flow control, turbulent flows, unsteady and separated flows, instabilities and transition, turbulence modeling, flow visualization techniques, computational fluid dynamics; metallurgical and materials engineering, including microstructural characterization, physical metallurgy of ferrous and nonferrous alloys, powder materials, laser processing and machining, high temperature structural materials, mechanical behavior, fatigue and fracture, environmental fatigue and fracture, computational x-ray diffraction analysis, texture, recrystallization and computational methods in materials processing; solids and structures, including experimental mechanics of composites and cellular solids, high strain rate constitutive modeling and thermomechanical coupling, fracture mechanics, design and testing of prosthetic devices; computational mechanics, cable dynamics and analysis of inelastic solids; theoretical mechanics, including wave propagation, fracture, elasticity and models for scoliosis; computer added design and manufacturing, concentrated in the areas of computer-aided design, computer-based machine tool control, computer graphics in design, manufacturing processes, wear and fracture behavior of cutting tools, tribology, frictional wear characteristics of ceramics, dynamic systems, and mechanical vibrations; thermal sciences, alternative fuels, mobile and stationary source combustion emissions, and dynamics and control, including guidance, navigation, and control of aircraft and spacecraft, intelligent control for aircraft models, flow fields, robotics devices for laser machining; and dynamic analysis and control of complex systems.

Admission Requirements

Cumulative minimum undergraduate GPA: 3.0/4.0

GRE score minimum:
1000 (quantitative + verbal) 3.0 (analytical writing)
Typical admitted quantitative score is 650.
TOEFL minimum: 550/213/80[1]

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are only two of several important factors considered. Admission as a regular graduate student normally requires a bachelor's degree from an accredited institution in mechanical engineering, aerospace engineering, metallurgical engineering, materials engineering, or engineering mechanics. A candidate with a bachelor's degree in another field, and with proficiency in other engineering disciplines, mathematics, and physics, may also be eligible for admission. However, students must remove any deficiencies in essential undergraduate courses that are prerequisites for the chosen degree program, in addition to meeting the other requirements of the graduate program.

The chair for graduate programs serves as a temporary adviser to new full-time and part-time graduate students admitted to the department as matriculated students until an appropriate faculty member is selected as the adviser. Students are responsible for following the departmental procedures for graduate study. A guide to graduate study in the department is available on the departmental website and in the MMAE main office (243 John T. Rettaliata Engineering Center) to all registered MMAE graduate students, and should be consulted regularly for information on procedures, deadlines, forms, and examinations. Departmental seminars and colloquia are conducted on a regular basis. All full-time graduate students must register for the MMAE 593 seminar course each semester and attend them regularly.

The department reserves the right to review and approve or deny the application for admission of any prospective degree-seeking student. Non-degree graduate students who intend to seek a graduate degree from the department must maintain a GPA of 3.0 and must apply for admission as a degree-seeking student prior to the completion of 9 credit hours of study. Maintaining the minimum GPA requirement does not guarantee admission to MMAE graduate degree programs. A maximum of 9 credit hours of approved coursework taken as a non-degree student and passed with a grade of "B" or better may be applied to the degree.

1 Paper-based/computer-based/internet-based test score.

Degrees Offered

Interdisciplinary Programs

Certificate Program

Course Descriptions

MMAE 501
Engineering Analysis I
Vectors and matrices, systems of linear equations, linear transformations, eigenvalues and eigenvectors, systems of ordinary differential equations, decomposition of matrices, and functions of matrices. Eigenfunction expansions of differential equations, self-adjoint differential operators, Sturm-Liouville equations. Complex variables, analytic functions and Cauchy-Riemann equations, harmonic functions, conformal mapping, and boundary-value problems. Calculus of variations, Euler's equation, constrained functionals, Rayleigh-Ritz method, Hamilton's principle, optimization and control. Prerequisite: An undergraduate course in differential equations.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 502
Engineering Analysis II
Generalized functions and Green's functions. Complex integration: series expansions of complex functions, singularities, Cauchy's residue theorem, and evaluation of real definite integrals. Integral transforms: Fourier and Laplace transforms, applications to partial differential equations and integral equations.
Prerequisite(s): [(MMAE 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 503
Advanced Engineering Analysis
Selected topics in advanced engineering analysis, such as ordinary differential equations in the complex domain, partial differential equations, integral equations, and/or nonlinear dynamics and bifurcation theory, chosen according to student and instructor interest.
Prerequisite(s): [(MMAE 502)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 508
Perturbation Methods
Asymptotic series, regular and singular perturbations, matched asymptotic expansions, and WKB theory. Methods of strained coordinates and multiple scales. Application of asymptotic methods in science and engineering.
Prerequisite(s): [(MMAE 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 509
Introduction to Continuum Mechanics
A unified treatment of topics common to solid and fluid mechanics. Cartesian tensors. Deformation, strain, rotation and compatibility equations. Motion, velocity gradient, vorticity. Momentum, moment of momentum, energy, and stress tensors. Equations of motion, frame indifference. Constitutive relations for elastic, viscoelastic, and fluids and plastic solids.
Prerequisite(s): [(MMAE 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 510
Fundamentals of Fluid Mechanics
Kinematics of fluid motion. Constitutive equations of isotropic viscous compressible fluids. Derivation of Navier-Stokes equations. Lessons from special exact solutions, self-similarity. Admissibility of idealizations and their applications; inviscid, adiabatic, irrotational, incompressible, boundary-layer, quasi one-dimensional, linearized and creeping flows. Vorticity theorems. Unsteady Bernoulli equation. Basic flow solutions. Basic features of turbulent flows.
Prerequisite(s): [(MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 4 **Lab:** 0 **Credits:** 4

MMAE 511
Dynamics of Compressible Fluids
Low-speed compressible flow past bodies. Linearized, subsonic, and supersonic flow past slender bodies. Similarity laws. Transonic flow. Hypersonic flow, mathematical theory of characteristics. Applications including shock and nonlinear wave interaction in unsteady one-dimensional flow and two-dimensional, planar and axisymmetric supersonic flow.
Prerequisite(s): [(MMAE 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 512
Dynamics of Viscous Fluids
Navier-Stokes equations and some simple exact solutions. Oseen-Stokes flows. Boundary-layer equations and their physical interpretations. Flows along walls, and in channels. Jets and wakes. Separation and transition to turbulence. Boundary layers in unsteady flows. Thermal and compressible boundary layers. Mathematical techniques of similarity transformation, regular and singular perturbation, and finite differences.
Prerequisite(s): [(MMAE 510)]
Lecture: 4 **Lab:** 0 **Credits:** 4

MMAE 513
Turbulent Flows
Stationary random functions. Correlation tensors. Wave number space. Mechanics of turbulence. Energy spectrum. Dissipation and energy cascade. Turbulence measurements. Isotropic turbulence. Turbulent transport processes. Mixing and free turbulence. Wall-constrained turbulence. Compressibility effects. Sound and pseudo-sound generated by turbulence. Familiarity with basic concepts of probability and statistics and with Cartesian tensors is assumed.
Prerequisite(s): [(MMAE 510)]
Lecture: 4 **Lab:** 0 **Credits:** 4

MMAE 514
Stability of Viscous Flows
Concept of hydrodynamic stability. Governing equations. Analytical and numerical treatment of eigenvalue problems and variational methods. Inviscid stability of parallel flows and spiral flows. Thermal instability and its consequences. Stability of channel flows, layered fluid flows, jets and flows around cylinders. Other effects and its consequences; moving frames, compressibility, stratification, hydromagnetics. Nonlinear theory and energy methods. Transition to turbulence.
Prerequisite(s): [(MMAE 502 and MMAE 510)]
Lecture: 4 **Lab:** 0 **Credits:** 4

MMAE 515
Engineering Acoustics
Characteristics of sound waves in two and three dimensions. External and internal sound wave propagation. Transmission and reflection of sound waves through media. Sources of sound from fixed and moving bodies. Flow-induced vibrations. Sound-level measurement techniques.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 516
Advanced Experimental Methods in Fluid Mechanics
Design and use of multiple sensor probes to measure multiple velocity components, reverse-flow velocities, Reynolds stress, vorticity components and intermittency. Simultaneous measurement of velocity and temperature. Theory and use of optical transducers, including laser velocimetry and particle tracking. Special measurement techniques applied to multiphase and reacting flows. Laboratory measurements in transitional and turbulent wakes, free-shear flows, jets, grid turbulence and boundary layers. Digital signal acquisitions and processing. Instructor's consent required.
Lecture: 2 **Lab:** 3 **Credits:** 3

MMAE 517
Computational Fluid Dynamics
Classification of partial differential equations. Finite-difference methods. Numerical solution techniques including direct, iterative, and multigrid methods for general elliptic and parabolic differential equations. Numerical algorithms for solution of the Navier-Stokes equations in the primitive-variables and vorticity-stream function formulations. Grids and grid generation. Numerical modeling of turbulent flows. Additional Prerequisite: An undergraduate course in numerical methods.
Prerequisite(s): [(MMAE 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 518
Spectral Methods in Computational Fluid Dynamics
Application of advanced numerical methods and techniques to the solution of important classes of problems in fluid mechanics. Emphasis is in methods derived from weighted-residuals approaches, like Galerkin and Galerkin-Tau methods, spectral and pseudospectral methods, and dynamical systems modeling via projections on arbitrary orthogonal function bases. Finite element and spectral element methods will be introduced briefly in the context of Galerkin methods. A subsection of the course will be devoted to numerical turbulence modeling, and to the problem of grid generation for complex geometries.
Prerequisite(s): [(MMAE 501 and MMAE 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 519
Cardiovascular Fluid Mechanics
Anatomy of the cardiovascular system. Scaling principles. Lumped parameter, one-dimensional linear and nonlinear wave propagation, and three-dimensional modeling techniques applied to simulate blood flow in the cardiovascular system. Steady and pulsatile flow in rigid and elastic tubes. Form and function of blood, blood vessels, and the heart from an engineering perspective. Sensing, feedback, and control of the circulation. Includes a student project.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 520
Advanced Thermodynamics
Macroscopic thermodynamics: first and second laws applied to equilibrium in multicomponent systems with chemical reaction and phase change, availability analysis, evaluations of thermodynamic properties of solids, liquids, and gases for single and multicomponent systems. Applications to contemporary engineering systems. Prerequisite: An undergraduate course in applied thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 522
Nuclear, Fossil-Fuel, and Sustainable Energy Systems
Principles, technology, and hardware used for conversion of nuclear, fossil-fuel, and sustainable energy into electric power will be discussed. Thermodynamic analysis -- Rankine cycle. Design and key components of fossil-fuel power plants. Nuclear fuel, reactions, materials. Pressurized water reactors (PWR). Boiling water reactors (BWR). Canadian heavy water (CANDU) power plants. Heat transfer from the nuclear fuel elements. Introduction to two phase flow: flow regimes; models. Critical heat flux. Environmental effects of coal and nuclear power. Design of solar collectors. Direct conversion of solar energy into electricity. Wind power. Geothermal energy. Energy conservation and sustainable buildings. Enrichment of nuclear fuel. Nuclear weapons and effects of the explosions.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 523
Fundamentals of Power Generation
Thermodynamic, combustion, and heat transfer analyses relating to steam-turbine and gas-turbine power generation. Environmental impacts of combustion power cycles. Consideration of alternative and sustainable power generation processes such as wind and tidal, geothermal, hydroelectric, solar, fuel cells, nuclear power, and microbial. Prerequisite: An undergraduate course in applied thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 524
Fundamentals of Combustion
Combustion stoichiometry. Chemical equilibrium. Adiabatic flame temperature. Reaction kinetics. Transport processes. Gas flames classification. Premixed flames. Laminar and turbulent regimes. Flame propagation. Deflagrations and detonations. Diffusion flames. Spray combustion. The fractal geometry of flames. Ignition theory. Pollutant formation. Engine combustion. Solid phase combustion. Combustion diagnostics. Prerequisite: An undergraduate course in thermodynamics and heat transfer or instructor consent.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 525
Fundamentals of Heat Transfer
Modes and fundamental laws of heat transfer. The heat equations and their initial and boundary conditions. Conduction problems solved by separation of variables. Numerical methods in conduction. Forced and natural convection in channels and over exterior surfaces. Similarity and dimensionless parameters. Heat and mass analogy. Effects of turbulence. Boiling and condensation. Radiation processes and properties. Blackbody and gray surfaces radiation. Shape factors. Radiation shields. Prerequisite: An undergraduate course in heat transfer.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 526
Heat Transfer: Conduction
Fundamental laws of heat conduction. Heat equations and their initial and boundary conditions. Steady, unsteady and periodic states in one or multidimensional problems. Composite materials. Methods of Green's functions, eigenfunction expansions, finite differences, finite element methods.
Prerequisite(s): [(MMAE 502 and MMAE 525)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 527
Heat Transfer: Convection and Radiation
Convective heat transfer analyses of external and internal flows. Forced and free convection. Dimensional analysis. Phase change. Heat and mass analogy. Reynolds analogy. Turbulence effects. Heat exchangers, regenerators. Basic laws of Radiation Heat Transfer. Thermal radiation and quantum mechanics pyrometry. Infrared measuring techniques.
Prerequisite(s): [(MMAE 525)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 529
Theory of Plasticity
Phenomenological nature of metals, yield criteria for 3-D states of stress, geometric representation of the yield surface. Levy-Mises and Prandtl-Reuss equations, associated and non-associated flow rules, Drucker's stability postulate and its consequences, consistency condition for nonhardening materials, strain hardening postulates. Elastic plastic boundary value problems. Computational techniques for treatment of small and finite plastic deformations.
Prerequisite(s): [(MMAE 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 530
Advanced Mechanics of Solids
Mathematical foundations: tensor algebra, notation and properties, eigenvalues and eigenvectors. Kinematics: deformation gradient, finite and small strain tensors. Force and equilibrium: concepts of traction/stress, Cauchy relation, equilibrium equations, properties of stress tensor, principal stresses. Constitutive laws: generalized Hooke's law, anisotropy and thermoelasticity. Boundary value problems in linear elasticity: plane stress, plane strain, axisymmetric problems, Airy stress function. Energy methods for elastic solids. Torsion. Elastic and inelastic stability of columns.
Prerequisite(s): [(MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 531
Theory of Elasticity
Notion of stress and strain, field equations of linearized elasticity. Plane problems in rectangular and polar coordinates. Problems without a characteristic length. Plane problems in linear elastic fracture mechanics. Complex variable techniques, energy theorems, approximate numerical techniques.
Prerequisite(s): [(MMAE 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 532
Advanced Finite Element Methods
Continuation of MMAE 451/CAE 442. Covers the theory and practice of advanced finite element procedures. Topics include implicit and explicit time integration, stability of integration algorithms, unsteady heat conduction, treatment of plates and shells, small-strain plasticity, and treatment of geometric nonlinearity. Practical engineering problems in solid mechanics and heat transfer are solved using MATLAB and commercial finite element software. Special emphasis is placed on proper time step and convergence tolerance selection, mesh design, and results interpretation.
Prerequisite(s): [(CAE 442) OR (MMAE 451)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 533
Fatigue and Fracture Mechanics
Analysis of the general state of stress and strain in solids; dynamic fracture tests (FAD, CAT). Linear elastic fracture mechanics (LEFM), Griffith-Irwin analysis, ASTM, KIC, KIPCI, KIA, KID. Plane stress, plane strain; yielding fracture mechanics (COD, JIC). Fatigue crack initiation. Goodman diagrams and fatigue crack propagation. Notch sensitivity and stress concentrations. Low-cycle fatigue, corrosion and thermal fatigue. Prerequisite: An undergraduate course in mechanics of solids.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 535
Wave Propagation
This is an introductory course on wave propagation. Although the ideas are presented in the context of elastic waves in solids, they easily carry over to sound waves in water and electromagnetic waves. The topics include one dimensional motion of elastic continuum, traveling waves, standing waves, energy flux, and the use of Fourier integrals. Problem statement in dynamic elasticity, uniqueness of solution, basic solution of elastodynamics, integral representations, steady state time harmonic response. Elastic waves in unbounded medium, plane harmonic waves in elastic half-spaces, reflection and transmission at interfaces, Rayleigh waves, Stoneley waves, slowness diagrams, dispersive waves in waveguides and phononic composites, thermal effects and effects of viscoelasticity, anisotropy, and nonlinearity on wave propagation.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 536
Experimental Solid Mechanics
Review of applied elasticity. Stress, strain and stress-strain relations. Basic equations and boundary value problems in plane elasticity. Methods of strain measurement and related instrumentation. Electrical resistance strain gauges, strain gauge circuits and recording instruments. Analysis of strain gauge data. Brittle coatings. Photoelasticity; photoelastic coatings; moire methods; interferometric methods. Applications of these methods in the laboratory. Prerequisite: An undergraduate course in mechanics of solids.
Lecture: 3 **Lab:** 2 **Credits:** 4

MMAE 540
Robotics
Kinematics and inverse kinematics of manipulators. Newton-Euler dynamic formulation. Independent joint control. Trajectory and path planning using potential fields and probabilistic roadmaps. Adaptive control. Force control.
Prerequisite(s): [(MMAE 443 and MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 541
Advanced Dynamics
Kinematics of rigid bodies. Rotating reference frames and coordinate transformations; Inertia dyadic. Newton-Euler equations of motion. Gyroscopic motion. Conservative forces and potential functions. Generalized coordinates and generalized forces. Lagrange's equations. Holonomic and nonholonomic constraints. Lagrange multipliers. Kane's equations. Elements of orbital and spacecraft dynamics. Additional Prerequisite: An undergraduate course in dynamics.
Prerequisite(s): [(MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 542
Applied Dynamical Systems
This course will cover analytical and computational methods for studying nonlinear ordinary differential equations especially from a geometric perspective. Topics include stability analysis, perturbation theory, averaging methods, bifurcation theory, chaos, and Hamiltonian systems.
Prerequisite(s): [(MMAE 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 543
Modern Control Systems
Review of classical control. Discrete-time systems. Linear difference equations. Z-transform. Design of digital controllers using transform methods. State-space representations of continuous and discrete-time systems. State feedback. Controllability and observability. Pole placement. Optimal control. Linear-Quadratic Regulator (LQR). Probability and stochastic processes. Optimal estimation. Kalman Filter. Additional Prerequisite: An undergraduate course in classical control.
Prerequisite(s): [(MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 544
Design Optimization
Optimization theory and practice with examples. Finite-dimensional unconstrained and constrained optimization, Kuhn-Tucker theory, linear and quadratic programming, penalty methods, direct methods, approximation techniques, duality. Formulation and computer solution of design optimization problems in structures, manufacturing and thermofluid systems. Prerequisite: An undergraduate course in numerical methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 545
Advanced CAD/CAM
Interactive computer graphics in mechanical engineering design and manufacturing. Mathematics of three-dimensional object and curved surface representations. Surface versus solid modeling methods. Numerical control of machine tools and factory automation. Applications using commercial CAD/CAM in design projects.
Prerequisite(s): [(MMAE 445)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 546
Advanced Manufacturing Engineering
Introduction to advanced manufacturing processes, such as powder metallurgy, joining and assembly, grinding, water jet cutting, laser-based manufacturing, etc. Effects of variables on the quality of manufactured products. Process and parameter selection. Important physical mechanisms in manufacturing process. Prerequisite: An undergraduate course in manufacturing processes or instructor consent.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 547
Computer-Integrated Manufacturing Technologies
The use of computer systems in planning and controlling the manufacturing process including product design, production planning, production control, production processes, quality control, production equipment and plant facilities.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 551
Experimental Mechatronics
Team-based project. Microprocessor controlled electromechanical systems. Sensor and actuator integration. Basic analog and digital circuit design. Limited Enrollment.
Prerequisite(s): [(MMAE 443)]
Lecture: 2 **Lab:** 3 **Credits:** 3

MMAE 552
Introduction to the Space Environment
Overview of the space environment, particularly Earth's ionosphere, magnetosphere, and interplanetary space. Effects of solar activity on geospace variability. Basic plasma characteristics. Single particle motions. Waves in magnetized plasmas. Charged particle trapping in planetary magnetic fields and its importance in near-earth-space phenomena. Macroscopic equations for a conducting fluid. Ground and space-based remote sensing and in situ measurement techniques. Space weather effects on human-made systems. Students must have already taken undergraduate courses in electromagnetics and in fluid mechanics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 554
Electrical, Magnetic and Optical Properties of Materials
Electronic structure of solids. Conductors, semiconductors, dielectrics, superconductors. Ferroelectric and piezoelectric materials. Magnetic properties, magnetocrystalline, anisotropy, magnetic materials and devices. Optical properties and their applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 555
Introduction to Navigation Systems
Fundamental concepts of positioning and dead reckoning. Principles of modern satellite-based navigation systems, including GPS, GLONASS, and Galileo. Differential GPS (DGPS) and augmentation systems. Carrier phase positioning and cycle ambiguity resolution algorithms. Autonomous integrity monitoring. Introduction to optimal estimation, Kalman filters, and covariance analysis. Inertial sensors and integrated navigation systems.
Prerequisite(s): [(MMAE 443 and MMAE 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 556
Nanoscale Imaging and Manipulation
Includes an overview of scanning probe microscopy and of AFM imaging: mathematical morphology; imaging simulation and surface recognition; and high-speed AFM imaging. Also covers nanoscale physics, including probing nanoscale forces, van der Waals force, electrostatic force, and capillary force. Nanomanipulation topics such as mechanical scratching and pushing electrophoresis, and augmented reality. Manipulation automation and manipulation planning. Applications of selected topics covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 557
Computer-Integrated Manufacturing Systems
Advanced topics in Computer-Integrated Manufacturing, including control systems, group technology, cellular manufacturing, flexible manufacturing systems, automated inspection, lean production, Just-In-Time production, and agile manufacturing systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 560
Statistical Quality and Process Control
Basic theory, methods and techniques of on-line, feedback quality control systems for variable and attribute characteristics. Methods for improving the parameters of the production, diagnosis, and adjustment processes so that quality loss is minimized. Same as CHE 560.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 561
Solidification and Crystal Growth
Properties of melts and solids. Thermodynamic and heat transfer concepts. Single and poly-phase alloys. Macro and micro segregation. Plane-front solidification. Solute boundary layers. Constitutional supercooling. Convection in freezing melts. Effective segregation coefficients. Zone freezing and purification. Single crystal growth technology. Czochralski, Kyropulous, Bridgman, and Floating Zone methods. Control of melt convection and crystal composition. Equipment. Process control and modeling. Laboratory demonstration. Prerequisite: A background in crystal structure and thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 562
Design of Modern Alloys
Phase rule, multicomponent equilibrium diagrams, determination of phase equilibria, parameters of alloy development, prediction of structure and properties. Prerequisite: A background in phase diagrams and thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 563
Advanced Mechanical Metallurgy
Analysis of the general state of stress and strain in solids. Analysis of elasticity and fracture, with a major emphasis on the relationship between properties and structure. Isotropic and anisotropic yield criteria. Testing and forming techniques related to creep and superplasticity. Deformation mechanism maps. Fracture mechanics topics related to testing and prediction of service performance. Static loading to onset of rapid fracture, environmentally assisted cracking fatigue, and corrosion fatigue. Prerequisite: A background in mechanical properties.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 564
Dislocations and Strengthening Mechanisms
Basic characteristics of dislocations in crystalline materials. Dislocations and slip phenomena. Application of dislocation theory to strengthening mechanisms. Strain hardening. Solid solution and particle strengthening. Dislocations and grain boundaries. Grain size strengthening. Creep. Fatigue. Prerequisite: Background in materials analysis.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 565
Materials Laboratory
Advanced synthesis projects studying microstructure and properties of a series of binary and ternary alloys. Gain hands-on knowledge of materials processing and advanced materials characterization through an integrated series of experiments to develop understanding of the processing-microstructure-properties relationship. Students arc melt a series of alloys, examine the cast microstructures as a function of composition using optical and electron microscopy, DTA, EDS, and XRD. The alloys are treated in different thermal and mechanical processes. The microstructural and mechanical properties modification and changes during these processes are characterized. Groups of students will be assigned different alloy systems, and each group will present their results orally to the class and the final presentation to the whole materials science and engineering group.
Lecture: 1 **Lab:** 6 **Credits:** 3

MMAE 566
Problems in High-Temperature Materials
Temperature-dependent mechanical properties. Creep mechanisms. Basic concepts in designing in high-temperature materials. Metallurgy of basic alloy systems. Surface stability. High-temperature oxidation. Hot corrosion. Coatings and protection. Elements of process metallurgy.Prerequisite: Background in mechanical properties, crystal defects, and thermodynamics.
Prerequisite(s): [(MMAE 564)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 567
Fracture Mechanisms
Basic mechanisms of fracture and embrittlement of metals. Crack initiation and propagation by cleavage, microvoid coalescence, and fatigue mechanisms. Hydrogen embrittlement, stress corrosion cracking and liquid metal embrittlement. Temper brittleness and related topics.Prerequisite: Background in crystal structure, defects, and mechanical properties.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 568
Diffusion
Theory, techniques and interpretation of diffusion studies in metals. Prerequisite: Background in crystal structures, defects, and thermodynamics.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 569
Advanced Physical Metallurgy
Thermodynamics and kinetics of phase transformations, theory of nucleation and growth, metastability, phase diagrams.Prerequisite: Background in phase diagrams and thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 570
Computational Methods in Materials Science and Engineering
Advanced theories and computational methods used to understand and predict material properties. This course will introduce energy models from classical and first-principles approaches, density functional theory, molecular dynamics, thermodynamic modeling, Monte Carlo simulations, and data mining in materials science. The course will also include case studies of computational materials research (e.g. alloy design, energy storage, nanoscale properties). The course consists of both lectures and computer labs. Background in thermodynamics is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 571
Miscrostructural Characterization of Materials
Advanced optical microscopy. Scanning and transmission electron microscopes. X-ray microanalysis. Surface characterization. Quantitative microscopy. Elements of applied statistics.
Lecture: 2 **Lab:** 3 **Credits:** 3

MMAE 573
Transmission Electron Microscopy
Design, construction and operation of transmission electron microscope, including image formation and principles of defect analysis in materials science applications. Theory and use of state-of-the-art micro characterization techniques for morphological, crystallographic, and elemental analysis at high spatial resolutions at 10 nanometers in metallurgical and ceramic studies will also be covered.
Lecture: 2 **Lab:** 3 **Credits:** 3

MMAE 574
Ferrous Transformations
Allotropic modifications in iron and solid solution effects of the important alloying elements on iron. Physical metallurgy of pearlite, bainite and martensite reactions. Physical and mechanical property changes during eutectoid decomposition and tempering.Prerequisite: Background in phase diagrams and thermodynamics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 576
Materials and Process Selection
Context of selection; decision analysis; demand, materials and processing profiles; design criteria; selection schemes; value and performance oriented selection; case studies.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 578
Fiber Composites
Basic concepts and definitions. Current and potential applications of composite materials. Fibers, Matrices, and overview of manufacturing processes for composites. Review of elasticity of anisotropic solids and transformation of stiffness/compliance matrices. Micromechanics: methods for determining mechanical properties of heterogeneous materials. Macromechanics: ply analysis, off-axis stiffness, description of laminates, laminated plate theories, special types of laminates. Applications of concepts to the design of simple composite structural components. Failure theories, hydrothermal effects.Prerequisite: Background in polymer synthesis and properties.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 579
Advanced Materials Processing
Processing science and fundamentals in making advanced materials, particularly nanomaterials and composites. Applications of the processing science to various processing technologies including severe plastic deformation, melt infiltration, sintering, co-precipitation, sol-gel process, aerosol synthesis, plasma spraying, vapor-liquid-solid growth, chemical vapor deposition, physical vapor deposition, atomic layer deposition, and lithography.
Prerequisite(s): [(MMAE 467)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 580
Thermodynamics in Materials Science
Classical thermodynamics with emphasis on solutions and phase equilibria in solids, liquids, and gases. Applications to unary and multicomponent, reacting and nonreacting, and homogeneous and heterogeneous systems including development of phase diagrams.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 585
Engineering Optics and Laser-Based Manufacturing
Fundamentals of geometrical and physical optics as related to problems in engineering design and research; fundamentals of laser-material interactions and laser-based manufacturing processes. This is a lecture-dominated class with around three experiments organized to improve students' understanding of the lectures. The topics covered include: geometrical optics (law of reflection and refraction, matrix method, etc.); physical optics (wave equations, interference, polarization, Fresnel equations, etc.); optical properties of materials and Drude theory; laser fundamentals; laser-matter interactions and laser-induced thermal and mechanical effects, laser applications in manufacturing (such as laser hardening, machining, sintering, shock peening, and welding). Knowledge of Heat & Mass Transfer required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 589
Applications in Reliability Engineering I
This first part of a two-course sequence focuses on the primary building blocks that enable an engineer to effectively communicate and contribute as a part of a reliability engineering effort. Students develop an understanding of the long term and intermediate goals of a reliability program and acquire the necessary knowledge and tools to meet these goals. The concepts of both probabilistic and deterministic design are presented, along with the necessary supporting understanding that enables engineers to make design trade-offs that achieve a positive impact on the design process. Strengthening their ability to contribute in a cross functional environment, students gain insight that helps them understand the reliability engineering implications associated with a given design objective, and the customer's expectations associated with the individual product or product platforms that integrate the design. These expectations are transformed into metrics against which the design can be measured. A group project focuses on selecting a system, developing a flexible reliability model, and applying assessment techniques that suggest options for improving the design of the system.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 590
Applications in Reliability Engineering II
This is the second part of a two-course sequence emphasizing the importance of positively impacting reliability during the design phase and the implications of not making reliability an integrated engineering function. Much of the subject matter is designed to allow the students to understand the risks associated with a design and provide the insight to reduce these risks to an acceptable level. The student gains an understanding of the methods available to measure reliability metrics and develops an appreciation for the impact manufacturing can have on product performance if careful attention is not paid to the influencing factors early in the development process. The discipline of software reliability is introduced, as well as the influence that maintainability has on performance reliability. The sequence culminates in an exhaustive review of the lesson plans in a way that empowers practicing or future engineers to implement their acquired knowledge in a variety of functional environments, organizations and industries. The group project for this class is a continuation of the previous course, with an emphasis on applying the tools and techniques introduced during this second of two courses.
Lecture: 3 **Lab:** 0 **Credits:** 3

MMAE 591
Research and Thesis M.S.
Credit: Variable

MMAE 593
MMAE Seminar
Reports on current research. Full-time graduate students in the department are expected to register and attend.
Lecture: 1 **Lab:** 0 **Credits:** 0

MMAE 594
Project for Master of Engineering Students
Design projects for the master of mechanical and aerospace engineering, master of materials engineering, and master of manufacturing engineering degrees.
Credit: Variable

MMAE 597
Special Topics
Advanced topic in the fields of mechanics, mechanical and aerospace, metallurgical and materials, and manufacturing engineering in which there is special student and staff interest. (Variable credit)
Credit: Variable

MMAE 600
Continuance of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

MMAE 691
Research and Thesis Ph.D.
Credit: Variable

MMAE 704
Introduction to Finite Element Analysis
This course provides a comprehensive overview of the theory and practice of the finite element method by combining lectures with selected laboratory experiences . Lectures cover the fundamentals of linear finite element analysis, with special emphasis on problems in solid mechanics and heat transfer. Topics include the direct stiffness method, the Galerkin method, isoperimetric finite elements, equation solvers, bandwidth of linear algebraic equations and other computational issues. Lab sessions provide experience in solving practical engineering problems using commercial finite element software. Special emphasis is given to mesh design and results interpretation using commercially available pre- and post-processing software.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 705
Computer Aided Design with Pro Engineer
This course provides an introduction to Computer-Aided Design and an associated finite element analysis technique. A series of exercises and instruction in Pro/ENGINEER will be completed. The operation of Mecanica (the associated FEM package) will also be introduced. Previous experience with CAD and FEA will definitely speed learning, but is not essential.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 707
High-Temperature Structural Materials
Creep mechanisms and resistance. The use of deformation mechanisms maps in alloy design. Physical and mechanical metallurgy of high-temperature, structural materials currently in use. Surface stability: High-temperature oxidation, hot corrosion, protective coatings. Alternative materials of the 21st century. Elements of process metallurgy.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 709
Overview of Reliability Engineering
This course covers the role of reliability in robust product design. It dwells upon typical failure mode investigation and develops strategies to design them out of the product. Topics addressed include reliability concepts, systems reliability, modeling techniques, and system availability predications. Case studies are presented to illustrate the cost-benefits due to pro-active reliability input to systems design, manufacturing and testing.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 710
Dynamic and Nonlinear Finite Element Analysis
Provides a comprehensive understanding of the theory and practice of advanced finite element procedures. The course combines lectures on dynamic and nonlinear finite element analysis with selected computer labs. The lectures cover implicit and explicit time integration techniques, stability of integration algorithms, treatment of material and geometric nonlinearity, and solution techniques for nonlinear finite element equations. The computer labs train student to solve practical engineering problems in solid mechanics and heat transfer using ABQUS and Hypermesh. Special emphasis is placed on proper time step and convergence tolerance selection, mesh design, and results interpretation. A full set of course notes will be provided to class participants as well as a CD-ROM containing course notes, written exercises, computer labs, and all worked out examples.
Prerequisite(s): [(MMAE 704)]
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 713
Engineering Economic Analysis
Introduction to the concepts of Engineering Economic Analysis, also known as micro-economics. Topics include equivalence, the time value of money, selecting between alternative, rate of return analysis, compound interest, inflation, depreciation, and estimating economic life of an asset.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 715
Project Management
This course will cover the basic theory and practice of project management from a practical viewpoint. Topics will include project management concepts, recourses, duration vs. effort, project planning and initiation, progress tracking methods, CPM and PERT, reporting methods, replanning, team project concepts, and managing multiple projects. Microsoft Project software will be used extensively.
Lecture: 2 **Lab:** 0 **Credits:** 2

MMAE 724
Introduction to Acoustics
This short course provides a brief introduction to the fundamentals of acoustics and the application to product noise prediction and reduction. The first part focuses on fundamentals of acoustics and noise generation. The second part of the course focuses on applied noise control.
Lecture: 2 **Lab:** 0 **Credits:** 2

Master of Engineering in Manufacturing Engineering

This program is aimed at broadening student potential beyond the B.S., enhancing technical versatility and, in some instances, providing the opportunity for changes in career path. The master of engineering program is a course-only degree program and requires a minimum of 30 credit hours. There is no thesis or comprehensive examination requirement. The student, in consultation with his or her adviser, prepares a program of study that reflects individual needs and interests. The adviser, as well as the department's graduate studies committee, the department chair, and the Graduate College must approve this program. Students working toward this degree are not eligible for departmental financial support.

Curriculum

Materials Science and Engineering Emphasis

Required Courses			(15)
MMAE 547	Computer-Integrated Manufacturing Technologies		3
MMAE 560	Statistical Quality and Process Control		3
Select a minimum of one course from the following:			3
MMAE 445	Computer-Aided Design	3	
MMAE 545	Advanced CAD/CAM	3	
MMAE 546	Advanced Manufacturing Engineering	3	
MMAE 576	Materials and Process Selection	3	
MMAE 574	Ferrous Transformations		3
or MMAE 585	Engineering Optics and Laser-Based Manufacturing		
Select a minimum of one course from the following numerical methods courses:			3
MMAE 451	Finite Element Methods in Engineering	3	
MMAE 517	Computational Fluid Dynamics	3	
MMAE 532	Advanced Finite Element Methods	3	
MMAE 544	Design Optimization	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
Elective Courses			(15)
Select 15 credit hours			15
Total Credit Hours			30

Mechanical and Aerospace Engineering Emphasis

Required Courses			(18)
MMAE 545	Advanced CAD/CAM		3
MMAE 546	Advanced Manufacturing Engineering		3
MMAE 547	Computer-Integrated Manufacturing Technologies		3
or MMAE 557	Computer-Integrated Manufacturing Systems		
MMAE 560	Statistical Quality and Process Control		3
Select a minimum of one course from the following:			3
MMAE 445	Computer-Aided Design	3	
MMAE 545	Advanced CAD/CAM	3	
MMAE 546	Advanced Manufacturing Engineering	3	
MMAE 547	Computer-Integrated Manufacturing Technologies	3	
MMAE 560	Statistical Quality and Process Control	3	
MMAE 574	Ferrous Transformations	3	
MMAE 576	Materials and Process Selection	3	
MMAE 585	Engineering Optics and Laser-Based Manufacturing	3	
Select a minimum of one course from the following numerical methods courses:			3
MMAE 451	Finite Element Methods in Engineering	3	
MMAE 517	Computational Fluid Dynamics	3	
MMAE 532	Advanced Finite Element Methods	3	
MMAE 544	Design Optimization	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	

Elective Courses			(12)
Select 12 credit hours			12
Total Credit Hours			30

Master of Engineering in Manufacturing Engineering via Internet

The Master of Engineering in Manufacturing Engineering via Internet is a course-only, professionally oriented degree program that requires a minimum of 30 credit hours. There is no thesis or comprehensive examination requirement. The student, in consultation with the academic adviser, prepares a program reflecting individual needs and interests. All courses are administered online.

Curriculum

Required Courses			(17)
MMAE 545	Advanced CAD/CAM		3
MMAE 546	Advanced Manufacturing Engineering		3
MMAE 560	Statistical Quality and Process Control		3
MMAE 547	Computer-Integrated Manufacturing Technologies		3
or MMAE 557	Computer-Integrated Manufacturing Systems		
MMAE 563	Advanced Mechanical Metallurgy (materials course)		3
MMAE 704	Introduction to Finite Element Analysis (numerical methods)		2
Elective Courses			(13)
Select a minimum of 13 credit hours from the following:			13
MMAE 433	Design of Thermal Systems	3	
MMAE 445	Computer-Aided Design	3	
MMAE 540	Robotics	3	
MMAE 557	Computer-Integrated Manufacturing Systems	3	
MMAE 589	Applications in Reliability Engineering I	3	
MMAE 590	Applications in Reliability Engineering II	3	
MMAE 715	Project Management	2	
Total Credit Hours			30

Master of Engineering in Materials Science and Engineering

This program is aimed at broadening student potential beyond the B.S., enhancing technical versatility and, in some instances, providing the opportunity for changes in career path. The master of engineering program is a course-only degree program and requires a minimum of 30 credit hours. There is no thesis or comprehensive examination requirement. The student, in consultation with his or her adviser, prepares a program of study that reflects individual needs and interests. The adviser, as well as the department's graduate studies committee, the department chair, and the Graduate College must approve this program. Students working toward this degree are not eligible for departmental financial support.

Curriculum

Required Courses			(18)
Select a minimum of six courses from the following:			18
MMAE 461	Failure Analysis	3	
MMAE 468	Introduction to Ceramic Materials	3	
MMAE 470	Introduction to Polymer Science	3	
MMAE 472	Advanced Aerospace Materials	3	
MMAE 501	Engineering Analysis I	3	
MMAE 520	Advanced Thermodynamics	3	
MMAE 533	Fatigue and Fracture Mechanics	3	
MMAE 554	Electrical, Magnetic and Optical Properties of Materials	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 562	Design of Modern Alloys	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 564	Dislocations and Strengthening Mechanisms	3	
MMAE 565	Materials Laboratory	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 567	Fracture Mechanisms	3	
MMAE 568	Diffusion	2	
MMAE 569	Advanced Physical Metallurgy	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	
MMAE 574	Ferrous Transformations	3	
MMAE 576	Materials and Process Selection	3	
MMAE 578	Fiber Composites	3	
MMAE 579	Advanced Materials Processing	3	
MMAE 580	Thermodynamics in Materials Science	3	
Elective Courses			(12)
Select 12 credit hours			12
Total Credit Hours			30

To complete the degree requirements, students may choose from a list of courses and may apply up to 9 credit hours of 400-level courses, as long as they were not used to satisfy requirements for an undergraduate degree. Up to 6 credit hours of accelerated (700-level) courses are allowed.

Master of Engineering in Mechanical and Aerospace Engineering

This program is aimed at broadening student potential beyond the B.S., enhancing technical versatility and, in some instances, providing the opportunity for changes in career path. The master of engineering program is a course-only degree program and requires a minimum of 30 credit hours. There is no thesis or comprehensive examination requirement. The student, in consultation with his or her adviser, prepares a program of study that reflects individual needs and interests. The adviser, as well as the department's graduate studies committee, the department chair, and the Graduate College must approve this program. Students working toward this degree are not eligible for departmental financial support.

Curriculum

Required Courses			(9-10)
MMAE 501	Engineering Analysis I		3
Select one core course in major area of study (see below)			3-4
Select a minimum of one course from the following:			3
MMAE 451	Finite Element Methods in Engineering	3	
MMAE 502	Engineering Analysis II	3	
MMAE 517	Computational Fluid Dynamics	3	
MMAE 532	Advanced Finite Element Methods	3	
MMAE 544	Design Optimization	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
Elective Courses			(20-21)
Select 20-21 credit hours			20-21

Minimum degree credits required: 30

Core Courses as Determined by Major Area of Study

Fluid Dynamics		(4)
MMAE 510	Fundamentals of Fluid Mechanics	4
Thermal Sciences		(3)
MMAE 520	Advanced Thermodynamics	3
Solids and Structures		(3)
MMAE 530	Advanced Mechanics of Solids	3
Dynamics and Controls		(3)
MMAE 541	Advanced Dynamics	3
Computer Aided Design and Manufacturing		(3)
MMAE 545	Advanced CAD/CAM	3

Students may choose from a list of courses specific to their area of interest to complete degree requirements. Up to 9 credit hours at the 400-level are allowed, assuming the courses were not required for an undergraduate degree. Up to 6 credit hours of accelerated (700-level) courses are allowed.

Master of Science in Manufacturing Engineering

The master of science degree program advances knowledge through post-baccalaureate coursework and state-of-the-art research in preparation for careers in industrial research and development. The M.S. degree is also generally acceptable as a prerequisite for study toward the doctorate. In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with his or her program adviser, in formulating an M.S. program.

The master of science degree requires completion of a minimum of 32 credit hours of approved work, which includes 6-8 credit hours of thesis research. Before completion of the first semester of graduate study, full-time students should select an area of specialization and a permanent adviser. Graduate students pursuing the M.S. degree on a part-time basis should select a permanent adviser before registering for their twelfth credit hour. The student, in consultation with the adviser, prepares a program of study that reflects individual needs and interests. The adviser must approve this program, as well as the department's graduate studies committee, the department chair, and the Graduate College.

After completion of the thesis, the student is required to pass an oral comprehensive examination on his or her thesis and related topics. The examination committee consists of at least three appropriate faculty members who are nominated by the thesis adviser and appointed by the department's graduate studies committee.

Curriculum

Materials Science and Engineering Emphasis

Required Courses			(15)
MMAE 547	Computer-Integrated Manufacturing Technologies		3
MMAE 560	Statistical Quality and Process Control		3
Select a minimum of one course from the following;			3
MMAE 445	Computer-Aided Design	3	
MMAE 545	Advanced CAD/CAM	3	
MMAE 546	Advanced Manufacturing Engineering	3	
MMAE 576	Materials and Process Selection	3	
Select a minimum of one course from the following:			3
MMAE 574	Ferrous Transformations	3	
MMAE 585	Engineering Optics and Laser-Based Manufacturing	3	
Select a minimum of one course from the following numerical methods courses:			3
MMAE 451	Finite Element Methods in Engineering	3	
MMAE 517	Computational Fluid Dynamics	3	
MMAE 532	Advanced Finite Element Methods	3	
MMAE 544	Design Optimization	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
Elective Courses			(9-11)
Select 9 to 11 credit hours			9-11
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8

Minimum degree credits required: 32

Mechanical and Aerospace Engineering Emphasis

Required Courses			(18)
MMAE 545	Advanced CAD/CAM		3
MMAE 546	Advanced Manufacturing Engineering		3
MMAE 547	Computer-Integrated Manufacturing Technologies		3
MMAE 560	Statistical Quality and Process Control		3
Select a minimum of one course from the following:			3
MMAE 445	Computer-Aided Design	3	
MMAE 574	Ferrous Transformations	3	
MMAE 576	Materials and Process Selection	3	
MMAE 585	Engineering Optics and Laser-Based Manufacturing	3	

Select a minimum of one course from the following:			3
MMAE 451	Finite Element Methods in Engineering	3	
MMAE 517	Computational Fluid Dynamics	3	
MMAE 532	Advanced Finite Element Methods	3	
MMAE 544	Design Optimization	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
Elective Courses			(6-8)
Select 8 to 11 credits			6-8
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8

Minimum degree credits required: 32

Master of Science in Materials Science and Engineering

The master of science degree program advances knowledge through post-baccalaureate coursework and state-of-the-art research in preparation for careers in industrial research and development. The M.S. degree is also generally acceptable as a prerequisite for study toward the doctorate. In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with his or her program adviser, in formulating an M.S. program.

The master of science degree requires completion of a minimum of 32 credit hours of approved work, which includes 6-8 credit hours of thesis research. Before completion of the first semester of graduate study, full-time students should select an area of specialization and a permanent adviser. Graduate students pursuing the M.S. degree on a part-time basis should select a permanent adviser before registering for their twelfth credit hour. The student, in consultation with the adviser, prepares a program of study that reflects individual needs and interests. The adviser must approve this program, as well as the department's graduate studies committee, the department chair, and the Graduate College.

After completion of the thesis, the student is required to pass an oral comprehensive examination on his or her thesis and related topics. The examination committee consists of at least three appropriate faculty members who are nominated by the thesis adviser and appointed by the department's graduate studies committee.

Curriculum

Required Courses			(18)
Select a minimum of six courses from the following:			18
MMAE 461	Failure Analysis	3	
MMAE 468	Introduction to Ceramic Materials	3	
MMAE 470	Introduction to Polymer Science	3	
MMAE 472	Advanced Aerospace Materials	3	
MMAE 501	Engineering Analysis I	3	
MMAE 520	Advanced Thermodynamics	3	
MMAE 533	Fatigue and Fracture Mechanics	3	
MMAE 554	Electrical, Magnetic and Optical Properties of Materials	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 562	Design of Modern Alloys	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 564	Dislocations and Strengthening Mechanisms	3	
MMAE 565	Materials Laboratory	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 567	Fracture Mechanisms	3	
MMAE 568	Diffusion	2	
MMAE 569	Advanced Physical Metallurgy	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	
MMAE 574	Ferrous Transformations	3	
MMAE 576	Materials and Process Selection	3	

MMAE 578	Fiber Composites	3	
MMAE 579	Advanced Materials Processing	3	
MMAE 580	Thermodynamics in Materials Science	3	
Elective Courses			(6-8)
Select 6-8 credit hours of non-core courses			6-8
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8

Minimum degree credits required: 32

Up to 12 credit hours of 400-level, non-core courses that were not required for the completion of an undergraduate degree and approved by the department's graduate studies committee may count toward satisfying this requirement. Up to 6 credit hours of accelerated (700-level) courses are allowed.

Master of Science in Mechanical and Aerospace Engineering

The master of science degree program advances knowledge through post-baccalaureate coursework and state-of-the-art research in preparation for careers in industrial research and development. The M.S. degree is also generally acceptable as a prerequisite for study toward the doctorate. In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with his or her program adviser, in formulating an M.S. program.

The master of science degree requires completion of a minimum of 32 credit hours of approved work, which includes 6-8 credit hours of thesis research. Before completion of the first semester of graduate study, full-time students should select an area of specialization and a permanent adviser. Graduate students pursuing the M.S. degree on a part-time basis should select a permanent adviser before registering for their twelfth credit hour. The student, in consultation with the adviser, prepares a program of study that reflects individual needs and interests. The adviser must approve this program, as well as the department's graduate studies committee, the department chair, and the Graduate College.

After completion of the thesis, the student is required to pass an oral comprehensive examination on his or her thesis and related topics. The examination committee consists of at least three appropriate faculty members who are nominated by the thesis adviser and appointed by the department's graduate studies committee.

Curriculum

Required Courses		(9-10)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Select one core course in major area of study (see below)		3-4
Elective Courses		(14-17)
Select 14-17 credit hours		14-17
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

Core Courses as Determined by Major Area of Study

Fluid Dynamics		(4)
MMAE 510	Fundamentals of Fluid Mechanics	4
Thermal Sciences		(3)
MMAE 520	Advanced Thermodynamics	3
Solids and Structures		(3)
MMAE 530	Advanced Mechanics of Solids	3
Dynamics and Controls		(3)
MMAE 541	Advanced Dynamics	3
Computer Aided Design and Manufacturing		(3)
MMAE 545	Advanced CAD/CAM	3

No more than 9 credit hours of 400-level courses that were not required for the completion of an undergraduate degree will be accepted as satisfying part of the program. Students with interdisciplinary programs will be given special consideration. Up to 6 credit hours of accelerated (700-level) courses are allowed.

Doctor of Philosophy in Materials Science and Engineering

72 credit hours beyond the B.S.

This program provides advanced, research-based education and knowledge through advanced coursework, state-of-the-art and original research, and publication of novel results in preparation for careers in academia and industrial research and development.

The department offers programs leading to the Ph.D. in Mechanical and Aerospace Engineering and the Ph.D. in Materials Science and Engineering. The doctoral degree is awarded in recognition of a high level of mastery in one of the several fields of the department including a significant original research contribution. A student working toward the Ph.D. degree has great flexibility in formulating an overall program to meet individual needs under the guidance of an adviser and the department.

Further, the student must be accepted by a thesis adviser and pass a qualifying examination given by the department in order to be admitted to candidacy for the Ph.D. degree. The examination evaluates the student's background in order to determine the student's potential for achieving a doctorate.

The student, in consultation with the adviser, prepares a plan of study to meet individual needs and interests, which must then be approved by the adviser, the department's graduate studies committee, the department chair, and the Graduate College. The plan of study usually consists of at least one full year of advanced coursework beyond the master's degree, or equivalent, and a minimum of one full year of thesis research.

After the student essentially completes all coursework, he or she must pass the Ph.D. comprehensive examination. Conducted by the student's thesis advisory committee, this examination must be completed at least one year prior to graduation. Concentrated research to satisfy the requirements of a doctoral dissertation is ordinarily conducted after the comprehensive examination has been passed. The dissertation must be approved by the student's thesis advisory committee. Thesis research should be equivalent to at least one full year's work, corresponding to up to 36 thesis credit hours. This work is performed on campus; the department's graduate studies committee and the Dean of the Graduate College must approve off-campus research. The doctoral dissertation is expected to contain a distinct and substantial original contribution to the student's field of study. After the research has been completed and a preliminary draft of the dissertation is approved, the candidate defends his or her thesis at a final oral examination, which is open to the public.

Curriculum

Required Courses			(17-18)
Select a minimum of six courses from the following:			17-18
MMAE 461	Failure Analysis	3	
MMAE 468	Introduction to Ceramic Materials	3	
MMAE 470	Introduction to Polymer Science	3	
MMAE 472	Advanced Aerospace Materials	3	
MMAE 501	Engineering Analysis I	3	
MMAE 520	Advanced Thermodynamics	3	
MMAE 533	Fatigue and Fracture Mechanics	3	
MMAE 554	Electrical, Magnetic and Optical Properties of Materials	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 562	Design of Modern Alloys	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 564	Dislocations and Strengthening Mechanisms	3	
MMAE 565	Materials Laboratory	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 567	Fracture Mechanisms	3	
MMAE 568	Diffusion	2	
MMAE 569	Advanced Physical Metallurgy	3	
MMAE 570	Computational Methods in Materials Science and Engineering	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	
MMAE 574	Ferrous Transformations	3	

MMAE 576	Materials and Process Selection	3
MMAE 578	Fiber Composites	3
MMAE 579	Advanced Materials Processing	3
MMAE 580	Thermodynamics in Materials Science	3
Ph.D. Research		(24-36)
MMAE 691	Research and Thesis Ph.D.	24-36

Minimum degree credits required: 72

Doctor of Philosophy in Mechanical and Aerospace Engineering

72 credit hours beyond the B.S.

This program provides advanced, research-based education and knowledge through advanced coursework, state-of-the-art and original research, and publication of novel results in preparation for careers in academia and industrial research and development.

The department offers programs leading to the Ph.D. in Mechanical and Aerospace Engineering and the Ph.D. in Materials Science and Engineering. The doctoral degree is awarded in recognition of a high level of mastery in one of the several fields of the department including a significant original research contribution. A student working toward the Ph.D. degree has great flexibility in formulating an overall program to meet individual needs under the guidance of an adviser and the department.

Further, the student must be accepted by a thesis adviser and pass a qualifying examination given by the department in order to be admitted to candidacy for the Ph.D. degree. The examination evaluates the student's background in order to determine the student's potential for achieving a doctorate.

The student, in consultation with the adviser, prepares a plan of study to meet individual needs and interests, which must then be approved by the adviser, the department's graduate studies committee, the department chair, and the Graduate College. The plan of study usually consists of at least one full year of advanced coursework beyond the master's degree, or equivalent, and a minimum of one full year of thesis research.

After the student essentially completes all coursework, he or she must pass the Ph.D. comprehensive examination. Conducted by the student's thesis advisory committee, this examination must be completed at least one year prior to graduation. Concentrated research to satisfy the requirements of a doctoral dissertation is ordinarily conducted after the comprehensive examination has been passed. The dissertation must be approved by the student's thesis advisory committee. Thesis research should be equivalent to at least one full year's work, corresponding to up to 36 thesis credit hours. This work is performed on campus; the department's graduate studies committee and the Dean of the Graduate College must approve off-campus research. The doctoral dissertation is expected to contain a distinct and substantial original contribution to the student's field of study. After the research has been completed and a preliminary draft of the dissertation is approved, the candidate defends his or her thesis at a final oral examination, which is open to the public.

Curriculum

For students entering with a B.S.:

Required Courses		(27-30)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Select a minimum of two courses from group EA [1]		6-7
Select a minimum of one core course in major area of study		3-4
Select a minimum of one core course in second area		3-4
Select a minimum of 9 credit hours of non-core courses in major area		9
Elective Courses		(6-21)
Select 6 to 21 credits		6-21
Ph.D. Research		(24-36)
MMAE 691	Research and Thesis Ph.D.	24-36

Minimum degree credits required: 72

For students entering with an M.S., M.E., or Co-Terminal M.E.:

Required Courses		(15-17)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Select a minimum of two courses from group EA [1]		6-7
Select a minimum of one core course in major area of study		3-4
Ph.D. Research		(24-36)
MMAE 691	Research and Thesis Ph.D.	24-36

Minimum degree credits required: 72

Core Courses as Determined by Major Area of Study

Fluid Dynamics		(4)
MMAE 510	Fundamentals of Fluid Mechanics	4
Thermal Sciences		(3)
MMAE 520	Advanced Thermodynamics	3
Solids and Structures		(3)
MMAE 530	Advanced Mechanics of Solids	3
Dynamics and Controls		(3)
MMAE 541	Advanced Dynamics	3
Computer Aided Design and Manufacturing		(3)
MMAE 545	Advanced CAD/CAM	3

[1]Group EA

MMAE 503	Advanced Engineering Analysis	3
MMAE 508	Perturbation Methods	3
MMAE 509	Introduction to Continuum Mechanics	3
MMAE 512	Dynamics of Viscous Fluids	4
MMAE 515	Engineering Acoustics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 535	Wave Propagation	3
MMAE 544	Design Optimization	3
MMAE 545	Advanced CAD/CAM	3
ECE 511	Analysis of Random Signals	3
ECE 505	Applied Optimization for Engineers	3
ECE 531	Linear System Theory	3
ECE 567	Statistical Signal Processing	3

Master of Engineering in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in mechanical and aerospace, materials, chemical, environmental, or electrical engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, environmental issues related to energy extraction, conversion, and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices.

General Degree Requirements

Students pursuing a master's degree are required to take 30-32 credit hours beyond the requirements of a B.S. degree program. The Ph.D. program requires 72 credit hours beyond the bachelor of science. The curriculum consists of two components: department core courses that provide a strong background in basic principles of the chosen engineering field and E3 specialization courses. Selected E3 undergraduate courses may be substituted for graduate courses with the approval of the designated adviser, if the total undergraduate credit hours for the M.E. or M.S. degree do not exceed departmental constraints.

Students are also required to attend interdisciplinary seminars during their first and/or second semesters, which are offered as part of the regular graduate seminars by the departments. A student completing a M.S. or Ph.D. thesis or professional master's project will be a member of an interdisciplinary research team consisting of professors and students from chemical, environmental, electrical, materials, and mechanical engineering backgrounds, working in a cross-disciplinary group project. Each interdisciplinary team must include professors from different departments.

Policies and procedures regarding admission, advising, financial aid, and comprehensive examinations are established by the individual departments offering this program.

Curriculum

Code	Title		Credit Hours
Core Courses			(15)
CHE 543	Energy, Environment, and Economics		3
MMAE 468	Introduction to Ceramic Materials		3
MMAE 569	Advanced Physical Metallurgy		3
Select a minimum of one course from the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE 566	Electrochemical Engineering	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 470	Introduction to Polymer Science	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	

MMAE 579	Advanced Materials Processing	3	
Select a minimum of one course from the following:			3
CHE 567	Fuel Cell Fundamentals	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Electives			(6)
Select a minimum of 6 hours of elective courses			6
Total Credit Hours			30

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3

ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Engineering in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in mechanical and aerospace, materials, chemical, environmental, or electrical engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, environmental issues related to energy extraction, conversion, and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices.

General Degree Requirements

Students pursuing a master's degree are required to take 30-32 credit hours beyond the requirements of a B.S. degree program. The Ph.D. program requires 72 credit hours beyond the bachelor of science. The curriculum consists of two components: department core courses that provide a strong background in basic principles of the chosen engineering field and E3 specialization courses. Selected E3 undergraduate courses may be substituted for graduate courses with the approval of the designated adviser, if the total undergraduate credit hours for the M.E. or M.S. degree do not exceed departmental constraints.

Students are also required to attend interdisciplinary seminars during their first and/or second semesters, which are offered as part of the regular graduate seminars by the departments. A student completing a M.S. or Ph.D. thesis or professional master's project will be a member of an interdisciplinary research team consisting of professors and students from chemical, environmental, electrical, materials, and mechanical engineering backgrounds, working in a cross-disciplinary group project. Each interdisciplinary team must include professors from different departments.

Policies and procedures regarding admission, advising, financial aid, and comprehensive examinations are established by the individual departments offering this program.

Curriculum

Code	Title		Credit Hours
Engineering Analysis Courses			(6)
MMAE 501	Engineering Analysis I		3
MMAE 502	Engineering Analysis II		3
Core Courses			(9)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of one course from the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	

MMAE 524	Fundamentals of Combustion	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 524	Fundamentals of Combustion	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 526	Heat Transfer: Conduction	3	
MMAE 527	Heat Transfer: Convection and Radiation	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE/MMAE 560	Statistical Quality and Process Control	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Electives			(6)
Select 6 credit hours			6
Total Credit Hours			30

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3

MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Science in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in mechanical and aerospace, materials, chemical, environmental, or electrical engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, environmental issues related to energy extraction, conversion, and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices.

General Degree Requirements

Students pursuing a master's degree are required to take 30-32 credit hours beyond the requirements of a B.S. degree program. The Ph.D. program requires 72 credit hours beyond the bachelor of science. The curriculum consists of two components: department core courses that provide a strong background in basic principles of the chosen engineering field and E3 specialization courses. Selected E3 undergraduate courses may be substituted for graduate courses with the approval of the designated adviser, if the total undergraduate credit hours for the M.E. or M.S. degree do not exceed departmental constraints.

Students are also required to attend interdisciplinary seminars during their first and/or second semesters, which are offered as part of the regular graduate seminars by the departments. A student completing a M.S. or Ph.D. thesis or professional master's project will be a member of an interdisciplinary research team consisting of professors and students from chemical, environmental, electrical, materials, and mechanical engineering backgrounds, working in a cross-disciplinary group project. Each interdisciplinary team must include professors from different departments.

Policies and procedures regarding admission, advising, financial aid, and comprehensive examinations are established by the individual departments offering this program.

Curriculum

Code	Title	Credit Hours
Core Courses		(15)
CHE 543	Energy, Environment, and Economics	3
MMAE 468	Introduction to Ceramic Materials	3
MMAE 569	Advanced Physical Metallurgy	3
Select one of the following:		3

CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE 566	Electrochemical Engineering	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 470	Introduction to Polymer Science	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	
MMAE 579	Advanced Materials Processing	3	
Select a minimum of one course from the following:			3
CHE 567	Fuel Cell Fundamentals	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8
Electives			(0-2)
Select elective courses as needed			0-2

Minimum degree credits required: 32

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3

ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

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Policies and procedures regarding admission, advising, financial aid, and comprehensive examinations are established by the individual departments offering this program.

Curriculum

Code	Title		Credit Hours
Engineering Analysis Courses			(6)
MMAE 501	Engineering Analysis I		3
MMAE 502	Engineering Analysis II		3
Core Courses			(9)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of one course from the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
MMAE 524	Fundamentals of Combustion	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 524	Fundamentals of Combustion	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 526	Heat Transfer: Conduction	3	
MMAE 527	Heat Transfer: Convection and Radiation	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE/MMAE 560	Statistical Quality and Process Control	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8
Electives			(0-2)
Select elective courses as needed			0-2

Minimum degree credits required: 32

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3

CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Doctor of Philosophy in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3)

The Energy/Environment/Economics (E3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

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Policies and procedures regarding admission, advising, financial aid, and comprehensive examinations are established by the individual departments offering this program.

Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CHE 543	Energy, Environment, and Economics	3
Select 5 E3 courses from Groups A and/or B		15
Ph.D. Research		(24)
MMAE 691	Research and Thesis Ph.D.	24

Minimum degree credits required: 72

Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one E3 professor from outside the student's department.

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3

MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Certificate in Computer Integrated Design and Manufacturing

Curriculum

Required Courses			(12)
Select a minimum of four courses from the following:			12
MMAE 445	Computer-Aided Design	3	
MMAE 540	Robotics	3	
MMAE 545	Advanced CAD/CAM	3	
MMAE 547	Computer-Integrated Manufacturing Technologies	3	
MMAE 557	Computer-Integrated Manufacturing Systems	3	
Total Credit Hours			12

Chicago-Kent College of Law

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Dean
Harold J. Krent

Faculty with Research Interests
For more information regarding faculty visit the Chicago-Kent College of Law website.

Chicago-Kent College of Law is accredited by the American Bar Association and is a member of the Association of American Law Schools and the Order of the Coif. The law school is housed in a state-of-the-art, 10-story facility in the West Loop area of downtown Chicago. The building is a short walk from the Federal Building that houses the U.S. District Court, the U.S. Court of Appeals, and numerous federal agencies; the Daley Center, where the Illinois state courts sit; and LaSalle Street, the hub of law practice in Chicago. Being located in the heart of one of the major legal centers in the United States enables the law school to supplement its distinguished full-time faculty with outstanding practitioners and jurists who teach courses in their areas of expertise.

Research Centers

Center for Access to Justice and Technology

Chicago-Kent College of Law established the Center for Access to Justice and Technology (CAJT) to make justice more accessible to the public by promoting the use of the Internet in the teaching, practice, and public access to the law. The one focus of CAJT is to help *pro se* litigants obtain greater access to justice. Many self-represented litigants, even in simple cases, struggle to navigate through an unfamiliar and procedurally complex court system. The center conducts research, builds software tools, teaches classes, and supports faculty, staff, and student projects on access to justice and technology.

Center for Empirical Studies of Intellectual Property

The Center for Empirical Studies of Intellectual Property, the first academic center of its kind in the nation, promotes the application of empirical social science methods, both quantitative and qualitative, to studying important questions about innovation, creativity, and other issues related to intellectual property law.

Center for Information, Society, and Policy

The Center for Information, Society, and Policy is a collaboration among Chicago-Kent public policy experts and Illinois Institute of Technology technology experts. The center promotes interdisciplinary research into privacy and information security issues raised by information technologies and social networks. Experts include computer scientists, psychologists, lawyers, business experts, and theorists in systems design and human/system interfaces. Forming the center's interdisciplinary task forces, they focus on critical unsolved policy problems to find the appropriate balance of risks and benefits. Emphasis is placed on forging a shared understanding of the problems at hand and a common language with which to discuss and analyze proposed solutions.

Institute for Compliance

The Institute for Compliance promotes careers in financial compliance, trains and prepares students for such careers, increases knowledge of the importance of compliance, and provides various events for the Chicago-based compliance and legal community. It is the first institute of its kind located in a law school.

Institute for Law and the Humanities

The Institute for Law and the Humanities was created to facilitate, support, and encourage symposiums, lectures, scholarship, and faculty discussion on the relationship between law and other humanistic disciplines. It provides opportunities for faculty and students to integrate humanities-based studies with the study of law and explore the increasingly rich and diverse scholarship in areas such as legal philosophy, legal history, law and literature, and law and religion.

Institute for Law and the Workplace

The Institute for Law and the Workplace is a national center for research, training, dialogue, and reflection on the law that governs the workplace. The institute pools the resources of leading scholars and the practicing professional community to train students and professionals, monitor policies and trends, and reflect upon major issues in a neutral setting.

Institute for Science, Law and Technology

The Institute for Science, Law and Technology is a joint venture of the academic units of Illinois Institute of Technology designed to meet the growing need for science- and law-trained professionals capable of addressing the complex issues that arise in a global, technologically driven marketplace of ideas, product standards, and conflicts. The most difficult challenges at the intersection of law and science today arise from new technologies. New possibilities in biotechnology, such as cloning and genetic engineering, raise difficult questions about ethics and challenge traditional legal concepts. Environmental concerns about the generation of greenhouse gases, rain forest devastation, and sustainable development challenge public policy. The Internet and other new information networks escape legal control at national boundaries. The institute serves as a cross-disciplinary forum for lawyers, scientists, ethicists, psychologists, business people, designers, and engineers to confront the challenges presented by new technologies.

Institute on the Supreme Court of the United States

The Institute on the Supreme Court of the United States (ISCOTUS) educates internal and external audiences about the Court and its role in our constitutional system of government. ISCOTUS's Academic Center is designed to provide new opportunities that showcase the significant intellectual contributions of Chicago-Kent's faculty and to give students the opportunity to learn from appellate advocates with experience in the Court and from prominent jurists. The other two main components of ISCOTUS are Oyez®, a widely used multi-media database devoted to the Court and its work, and the Civic Education Project, which merges ISCOTUS's academic and technological dimensions to promote public education about the Court.

Justice John Paul Stevens Jury Center

Chicago-Kent's Jury Center serves as a clearinghouse for information about the jury to academics, students, judges, lawyers, and members of the press and public. The center's website provides a centralized resource for jury studies and includes an annotated bibliography with summaries of recent and forthcoming academic articles on capital juries, comparative jury systems, history of juries, jury behavior, jury selection, and public policy; a collected list of law review symposia on the jury; and links to other jury resources. The Jury Center also undertakes special projects, such as an evaluation of state court websites for prospective jurors.

The Law Lab

The Law Lab is an interdisciplinary teaching and research center devoted to legal futurism. The center examines the intersections of law and technology, mathematics, science, and engineering.

Research and Training Facilities

Chicago-Kent College of Law Library

The law library contains approximately 500,000 volumes and countless electronic subscriptions to a wide variety of online material. It supports Chicago-Kent College of Law and other graduate programs taught at the Downtown Campus. Areas of collection strength include law, business, and international relations, and the library is a depository for materials from the European Union, the United Nations, and the United States federal government. The library provides both wired and wireless access to the Internet, seats more than 400 people, and contains 10 group study rooms that may be reserved by Illinois Institute of Technology students. Seating throughout the library provides access to all of the online research systems, both remote (e.g., LexisNexis, Westlaw, and numerous other subscription databases) and internal, such as web-based interactive tutorials, computer-assisted legal instruction, productivity tools, and e-mail.

Computer Facilities

Chicago-Kent boasts a computer network that is among the most technologically advanced of any law school in the nation. Wireless technology allows complete access to the network and is available throughout much of the building, including the atrium area that spans the concourse, first and second floors; all floors of the library; many classrooms; and the student lounge. Students with laptops can also use network ports available almost everywhere in the building. Every seat in the library and almost every classroom seat has a hardwired computer node with adjacent power connections. Networked workstations are devoted to student use throughout the building in three computer labs as well as in student lounges, the library, and even the cafeteria and atrium. Web-based student resources, including online registration and grading systems, are available 24/7 from anywhere with an Internet connection. Faculty members routinely prepare interactive tutorials that can be accessed by students ahead of class.

The Judge Abraham Lincoln Marovitz Courtroom

The Judge Abraham Lincoln Marovitz Courtroom, named for the late distinguished Chicago-Kent graduate and senior judge of the U.S. District Court for the Northern District of Illinois, integrates design features from the best courtrooms and trial advocacy training facilities in the nation. Planned for both law school instruction and actual legal proceedings, the Marovitz Courtroom incorporates advanced computer and audiovisual technology in a traditional setting.

The Bruce M. Kohen Courtroom

The Bruce M. Kohen Courtroom is a 738-square-foot, state-of-the-art facility that includes two 90-inch television monitors, a Crestron automated lighting control system, and an audiovisual system with three built-in document cameras and four display monitors. Named for Bruce M. Kohen '79, a retired partner of Anesi, Ozmon, Rodin, Novak, & Kohen Ltd. in Chicago, the Kohen Courtroom provides a realistic courtroom atmosphere for classroom instruction and for competition practice by students on the law school's trial advocacy and moot court teams.

Research and Clinical Training Areas

Legal Research and Writing

Chicago-Kent has one of the most rigorous and comprehensive legal research and writing programs in the country. The required five-course curriculum introduces students to basic and advanced research techniques; memorandum and brief writing; transactional writing and client representation; and specialized research and writing in such areas as securities, labor and employment, environmental, international, public interest, or intellectual property law. The curriculum culminates in an intensive writing seminar.

Clinical Education

The Law Offices of Chicago-Kent, a teaching law office located in the law school, is one of the largest in-house clinical programs in the United States. The center is staffed by more than a dozen full-time attorneys and serves more than 1,000 clients each year. Students who intern in the law offices have the opportunity to work on cases in a wide variety of clinical practice areas—civil practice, criminal law, entrepreneurial law, environmental law, family law, intellectual property law, mediation, open government/government watchdog law (Center for Open Government), vaccine injury litigation, and tax law—under the supervision of a clinical professor. Other skills training opportunities are available through the Judicial and Legal Externship programs. Students in the Judicial Externship Program are placed with participating judges in the federal district, appellate, and bankruptcy courts, and in Illinois state courts at all levels. Judicial externs work directly with the judge and the judge's senior law clerk and perform the same duties as the law clerk, including researching, writing memoranda of law, drafting opinions, and generally observing and participating in the day-to-day operation of the court. Those selected for the Legal Externship Program work with teaching attorneys in a wide range of government and private practice settings.

Trial Advocacy

Chicago-Kent offers a two-semester sequence in trial advocacy taught by judges and practitioners with extensive trial experience. In the first semester, students practice jury selection, opening statements, direct examination, cross-examination, and closing arguments, and they conduct at least two full trials. In the second semester, students learn strategic trial techniques and conduct at least four full trials.

An advanced course in litigation technology ensures students are prepared to use computer technology in the courtroom, a critical aspect of contemporary trial practice.

Course Descriptions

See the Chicago-Kent College of Law website for detailed information about faculty and courses.

Admissions

Applicants for admission to Chicago-Kent must have received a bachelor's degree from an accredited college or university prior to beginning classes at the law school. Students are admitted to the law school based on the information contained in their applications, their LSAT scores, undergraduate records, personal statements, and their letters of recommendation.

All candidates must take the LSAT and register with the LSAC Credential Assembly Service. For additional information on admission requirements, potential students should contact the law school admissions office at 312.906.5020 or visit the Chicago-Kent admissions website at kentlaw.iit.edu.

Degrees Offered

Joint-Degree Programs

With Stuart School of Business

With University of Illinois at Chicago

Juris Doctor (J.D.)

The college offers both full-time and part-time divisions. Entrance, scholastic, and graduate requirements are the same for both divisions, and full-time faculty teach in both divisions. Entering classes begin only in the fall, but incoming first-year evening students may take one course during the summer semester before their first year. Three years are normally required for full-time day division students to complete the 87 credit hours needed for the Juris Doctor (J.D.) degree. Evening division and part-time day division students normally take four years, including one summer session, to graduate. A selection of courses is offered each summer, mostly in the evening. First-year courses are required, but full-time students participating in the 1L Your Way program may defer Legislation until the second year in favor of taking an approved elective or special clinical rotation during the spring term. Most courses in the second and third years are elective, although the faculty recommends that all students take certain upper-class courses. In addition to traditional courses, the curriculum offers a wide variety of innovative courses and seminars to enrich the student's academic experience.

Master of Laws (LL.M.)

Chicago-Kent offers Master of Laws (LL.M.) degree programs in family law; financial services law; international intellectual property law; taxation; trial advocacy; and U.S., international, and transnational law. Each program requires 24 credit hours. The courses are taught by outstanding practitioners and offer students the opportunity to do advanced research and writing under the direct supervision of a faculty member. A student may pursue these programs on a full-or part-time basis. The LL.M. degree programs in financial services law; international intellectual property law; trial advocacy; and U.S., international, and transnational law are offered to foreign attorneys. Chicago-Kent also offers combined J.D./LL.M. degree programs in taxation, family law, and financial services law, which enable students to earn both degrees after seven semesters of full-time residence, instead of eight.

Doctor of the Science of Law (J.S.D.)

The J.S.D. degree is Chicago-Kent's most advanced degree, designed primarily for those who are interested in sustained independent legal research and writing with the ultimate goal of pursuing a career in legal academics. The basic aim of the program is to provide opportunity and encouragement for distinguished scholarship through advanced coursework, seminars, colloquia, and independent research, under the advice and guidance of members of the Chicago-Kent faculty. To earn the degree, candidates are required to submit a dissertation and to pass an oral defense of the dissertation within five years of enrollment in the program.

J.D./LL.M. in Family Law

Chicago-Kent offers a combined J.D./LL.M. program in family law that allows students to gain the broad expertise required of contemporary family law practitioners. The practice-oriented curriculum—the only one of its kind in the United States—encompasses family law and attendant, increasingly complex issues of tax, finance, real estate, business entities, contracts, and child psychology.

J.D./LL.M. in Financial Services Law

Deregulation of financial services, tax reforms, and revolutionary market forces have created an environment in which attorneys and other professionals must broaden their knowledge and sharpen their analytical skills and understanding in these areas. The graduate program in financial services law offers both full- and part-time students a unique opportunity to broaden their understanding of the principles underlying increasingly complex systems and services, deepen their knowledge of particular topics of interest, and enhance their skills as professionals. Courses are offered on weekday evenings and on Saturdays.

J.D./LL.M. in Taxation

The law school offers a combined J.D./LL.M. program in taxation that enables a student to earn both a J.D. and a Master of Laws (LL.M.) in taxation in a total of seven semesters of full-time study, instead of eight. A student may take six LL.M. courses (12 credit hours of coursework) while a J.D. candidate. These 12 credit hours will be applied toward both the J.D. and the LL.M.

The student will earn the J.D. in the usual time but will then go on, as a graduate student with advanced standing, to earn the LL.M. in only one additional semester instead of two. A degree of Master of Laws in Taxation is a recognized certification of exceptional knowledge and skill in tax law and tax planning.

J.D./M.B.A.

A joint-degree J.D./M.B.A. program in conjunction with Stuart School of Business allows students to receive both J.D. and M.B.A. degrees in a reduced time period, depending on undergraduate preparation. The primary objective of the program is to provide law students with a strong academic background in management. This program is particularly valuable for those law students who intend to be involved in activities and commercial transactions within the business community. The M.B.A. program's focus on professional specialization, combined with business-oriented law courses in the law school curriculum, enhances a lawyer's ability to work effectively as part of the corporate and business worlds.

J.D./M.S. in Finance

The law school, in conjunction with Stuart School of Business, offers a joint-degree J.D./M.S. in Finance. The program is designed for students who wish to specialize in securities and commodities law for a law firm, brokerage firm, commodity exchange or trading company. Students gain a unique perspective on the economics of financial products and markets that are used to advise clients, to propose regulation, or to litigate.

J.D./M.S. in Sustainability Management

The law school offers a joint J.D./M.S. in Sustainability Management degree program in conjunction with Stuart School of Business. The Sustainability Management Program is a unique multidisciplinary program integrating engineering, law, and business management to answer the increasing demand for management-level personnel who have an understanding of environmental issues. An attorney with environmental training is able to work either as a lawyer or in corporate or governmental management.

J.D./M.P.A.

The law school offers a joint-degree J.D./M.P.A. in conjunction with Stuart School of Business. This program explores practices and policies in the public sector.

J.D./Master of Public Health (M.P.H.)

The law school offers a joint-degree J.D./M.P.H. in conjunction with the University of Illinois at Chicago. Students in the program must independently matriculate into the UIC School of Public Health. The comprehensive curriculum addresses contemporary issues at the intersection of public health, law, and medicine. Students in the joint-degree program acquire legal tools to help solve pressing public health problems, learn how to impact public policymakers, explore and understand the empirical assumptions about public health that drive legal decision-making, and discover how emerging medical technologies and new healthcare delivery mechanisms are likely to be regulated.

Certificate Programs

Students enrolled in the J.D. program at Chicago-Kent may earn certificates in specialized areas. Certificates indicate that, as part of the required J.D. curriculum, the student has completed an identified subset of elective courses in the area of specialization.

Business Law

The Business Law Certificate Program allows students to explore a broad range of business-related topics to build legal careers representing small and large businesses and corporations. Graduates have a solid understanding of the basic principles of business and commercial law and are familiar with the increasingly complex regulatory environment that business lawyers commonly encounter in practice. The curriculum includes traditional subjects such as business organizations, securities regulation, and taxation. It also allows students to focus on individual interests by including an extensive array of elective courses such as E-Commerce, International Capital Markets, Employment Relationships, and Futures Regulation. The program requires a total of 24 credit hours emphasizing both theory and practice. Students must take three required courses, two courses from a list of core courses, additional courses from a list of elective courses, and a specialized legal writing course, and must complete an experiential requirement.

Criminal Litigation

Chicago-Kent's Program in Criminal Litigation is designed to give students a comprehensive and balanced professional education to prepare them for the practice of criminal law. To earn the certificate, students must complete 25 credit hours of coursework from an approved curriculum. With emphases on both theory and practical skills development, the certificate program represents an opportunity to synthesize the goals of Chicago-Kent's academic program in criminal law with those of the Trial Advocacy Program and the Chicago-Kent Law Offices.

Environmental and Energy Law

The Program in Environmental and Energy Law trains students to be environmental and energy professionals, as well as law practitioners. Taking an interdisciplinary approach to the field's scientific, economic, and ethical aspects, the program immerses students in the statutes and administrative regulations, case decisions, and theoretical underpinnings of environmentalism. The program attracts students from a wide range of professions. A highly regarded faculty teaches a carefully considered curriculum addressing a wide variety of cutting-edge issues.

Students in the program complete 14 credit hours of approved coursework. If students are full-time, these courses are taken during the second and third years; if students are part-time, courses are taken during the second, third, and fourth years.

Intellectual Property Law

Intellectual property lawyers work where the law intersects with technology, science, and the arts to protect their clients' creative products. The field of intellectual property law focuses on issues relating to patents, copyrights, trade secrets, unfair competition, and antitrust. As part of the program's rigorous practical skills training, students learn how to draft intellectual property documents through specialized legal research and writing courses and develop litigation skills by participating in moot court competitions. The program encourages scholarship and discourse among academics, practitioners, and students with events like the Chicago Intellectual Property Colloquium. Students complete 20 credit hours of approved coursework, including courses in patent law, copyright law, and trademark and unfair competition law.

International and Comparative Law

In a climate of continuous change, Chicago-Kent's Program in International and Comparative Law addresses the law's global implications and extensive reach. Students can learn how to conduct an international business transaction, develop the skills to navigate between different legal regimes, and learn about the legal structures of international institutions and organizations. The program offers opportunities to link coursework to externships, foreign law study, and projects in nations across the globe. Students in the program must successfully complete 14 credit hours of course study in international and comparative law, including a 2-credit seminar.

Students can take advantage of the Library of International Relations, which contains a diverse collection of international legal, historical, and business-related reference materials and is a depository library for the United Nations and the European Union.

Labor and Employment Law

The Program in Labor and Employment Law is the centerpiece of Chicago-Kent's Institute for Law and the Workplace. Through a logical, carefully paced sequence of coursework and practical skills training, the program provides comprehensive, rigorous preparation for the field of labor and employment law. To earn a certificate, program participants must complete four core courses, a seminar course, a practicum, and an additional labor/employment elective. The core courses are Labor Law, Employment Relationships, Employment Discrimination, and a specialized advanced legal research and writing course in labor and employment law.

Litigation and Alternative Dispute Resolution

Chicago-Kent's Program in Litigation and Alternative Dispute Resolution offers an innovative curriculum that stresses the connection between legal doctrine, skills and values, and the art of lawyering. The program provides comprehensive training in trial skills, negotiation, and mediation, and a rigorous curriculum of clinical education. Students in the program complete a series of courses that includes evidence, pretrial litigation, trial advocacy, a judicial externship, and litigation and ADR clinical offerings. In-house clinical education takes place in the Law Offices of Chicago-Kent, the school's acclaimed teaching law firm, where students work with clinical professors on cases in criminal, civil rights, employment, family, and tax law, as well as vaccine injury litigation.

Praxis Program

The Praxis Program is designed for students who want to fully embrace a practice- or experience-based course of study. The curriculum capitalizes on the law school's already robust hands-on learning offerings to guide participants through an individualized course of study designed to provide exposure to the core competencies required of successful lawyers. Participating students must complete the course Practice and Professionalism, take 24 credit hours of experiential or skills-based coursework, create a professional online portfolio, and satisfy a list of required core experiences drawn from a list of practice-based competencies. Students enrolled in the Praxis Program may concurrently enroll in an additional, subject-matter certificate program offered by Chicago-Kent.

Public Interest Law

The Certificate in Public Interest Law builds on Chicago-Kent's strong public interest tradition and adds a concentrated curriculum to the rich array of activities, courses, and resources that encourage Chicago-Kent students to consider public interest law as a career and prepare students to be effective public interest lawyers. The certificate requires 12 credit hours, including Public Interest Law and Policy and a specialized advanced legal research and writing course concentrating on public interest law. Because the substantive scope of public interest lawyering is so broad, each student meets with the director of the program to plan additional courses that satisfy individual career and interest objectives.

Each student also meets several times with the Career Services Office to complete a personalized Public Interest Career Path Plan.

The Public Interest Law Certificate is distinct from, but coordinated with, the current volunteer program of pro bono activities at the law school. The Chicago-Kent Certificate of Service, which can be obtained by volunteering for pro bono service during law school under the Public Interest Resource Center (PIRC), is a requirement for the Certificate in Public Interest Law, but the PIRC certificate remains a distinct credential that any student can obtain.

College of Architecture

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Director of Admissions and Recruitment Management
Jaucinta Echols

Director of Doctoral Program
Michaelangelo Sabatino

Director of Master of Science in Architecture
Vedran Mimica

Director of Master of Landscape Architecture Program
Ron Henderson

Faculty with Research Interests
For more information regarding faculty visit the College of Architecture website.

Mission

The College of Architecture's graduate degree programs emphasize investigations in architectural design and technology, while expanding the significance of such investigations through rigorous, critical thought. The college draws strength from its Mies van der Rohe heritage, its key position in the legacy of Modernism, its location in Chicago, and its connections to progressive practitioners and emerging global architectural practices. Our students, faculty, and alumni are intellectually serious, professional, and international.

Architectural education at Illinois Institute of Technology offers unique combinations, intertwining design and technology to produce advanced architecture. Our commitment includes the needs of our South Side Chicago neighborhood, our city and its inhabitants. Our perspective is inclusive of architecture's allied disciplines and committed to the highest quality in our students' professional preparation. Our mission relies on certain guiding values: design excellence, technical expertise, advanced professional practice, and respect for the architect in society today as an ethical, thoughtful and informed producer not only of buildings, but also of all visual and physical environments. The College of Architecture is a force for quality built environments and society's advancement through a humane use of technology, materials, space, and form.

Accreditation

In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on the extent of its conformance with established educational standards. The Landscape Architecture Accreditation Board (LAAB) is the accrediting organization for landscape architectural programs. As such, the LAAB develops standards to objectively evaluate landscape architectural programs and judges whether a school's first professional degree program (Bachelor of Landscape Architecture and/or Master of Landscape Architecture) is in compliance with the accreditation standards.

Master's degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

The College of Architecture has two NAAB-accredited degrees: the Bachelor of Architecture and the Master of Architecture professional degree programs. Both hold 8-year terms of accreditation with the NAAB. The Landscape Architectural Accreditation Board (LAAB) evaluates professional landscape architecture programs in the United States to determine whether they meet objective standards of academic quality and properly prepare students for professional work. The Master of Landscape Architecture (M.L.A.) degree program holds a 6-year term of accreditation with the LAAB.

Research Facilities

The College of Architecture is housed in three buildings designed by Mies van der Rohe: S.R. Crown Hall, 3410 S. State St., and the Minerals and Metals Building. With more than 112,000 sq. feet dedicated exclusively to the college, along with seminar and classrooms utilizing many university campus facilities, students have some of the finest instructional spaces in the United States.

The Graham Resource Center (GRC) is the main library for College of Architecture (CoA) students and faculty. Housed in Crown Hall, the GRC houses over 16,000 books, a number of architecture specific databases, and 55 journal subscriptions. The GRC is charged with meeting all library-related needs of the CoA and responsibilities include: acquiring, preserving, and serving materials in myriad media to CoA students, faculty, and staff. The GRC also maintains additional resources, including the Crown Hall darkroom, the CoA archives, the Graham Resource Center web page, and an audio-visual equipment collection. The center provides reference and research assistance to local, national, and international clients about architecture in general, and Illinois Institute of Technology and Mies van der Rohe in particular, and provides bibliographic instruction to all GRC and architecture researchers and users.

The Architecture Materials Lab has 14,000 square feet of shop facilities. The lab contains tools and machinery for working with wood, metal, and plastics and includes a large paint booth. The facility houses four Universal Laser Systems 60W Laser Cutters, a Bridgeport Series I Vertical CNC Machine, a 3D Printer, and a Precix Series 9100 CNC Router for digital fabrication.

The college houses two computer labs, with a third instruction lab in Siegel Hall, with over 70 PCs outfitted with the latest architectural digital design and fabrication software. All labs and requisite software are listed here: iit.edu/ots/computer labs.shtml. The lab PCs are updated every third year to support curriculum initiatives and technology advances, such as BIM (Building Information Modeling), and serve as digital imaging and rendering instruction spaces for the college. When not in use for class, the labs are open to students and offer 24-hour access for several weeks at the end of the semester. The two labs support myriad printing and output media including four plotters for student use. In addition, the Office of Technology Services printing system allows students to print remotely to any printer on campus, including the aforementioned plotters. The campus is a wireless zone serving the university community.

Research Areas

Faculty and doctoral candidates conduct research on a wide range of important topics related to the theory and practice of architecture and landscape architecture. Thesis students investigate projects involving the design, planning and structure of high-rise buildings; urban agriculture; the research, planning, and design of large-scale projects such as stadiums, institutional buildings, and commercial facilities; technological applications such as new materials, composites, prefabricated applications, systems of building enclosure, and other methods of construction; emerging urbanisms, including global practices of architecture, landscape architecture, and new urban cultures; the influence of climate and environment upon building and landscape form, sustainable design and energy efficiency; biophilic design; advanced critical analysis and architectural and landscape architectural history/theory; computer applications such as 3-D modeling, multimedia and graphic image presentations, concepts of animation, and 3-D modeling techniques and approaches; and housing, including high-density, low-density, and affordable housing.

Cloud Studio

"Cloud studio" is a college-wide, innovative, design-based research course focused on investigating the complex forces that shape the built environment and proposing new strategies for urban development. The aim of the studio is to build a commentary and transformative agenda toward the future metropolis, and to drive urban and architectural design solutions with the most advanced technologies and critical thought. The studio production is oriented toward the development of new strategies and future urban models with the aim of advancing the knowledge of relationships between urban thinking and materiality, technology, energy, ecology, emerging media and socio-political and cultural concerns. Strong emphasis is put toward engagement with external parties and agencies, to connect the academic environment with the professional practice, and to promote cross-disciplinary collaboration.

"Cloud studio" is vertical studio accommodating advanced professional students (B.Arch., M.Arch., and M.L.A.) with those in the post-professional programs (M.S. and Ph.D.).

Admission Requirements

Completed online application form
Portfolio
Two letters of recommendation
Statement of intent
Official transcripts

GRE score minimum

292 combined, 2.5 analytical writing

TOEFL minimum

90/600 (internet/paper-based test scores)
Application fee of $60

All programs require a minimum undergraduate grade point average of 3.0 on a 4.0 scale.

Applicants must submit a portfolio of previous academic or professional work in a portable and professionally acceptable format (8.5 by 11 inches or smaller), two letters of recommendation from individuals able to appraise the applicant's achievement and potential, a statement of intent describing academic and professional objectives as well as why they would like to study at the university, and GRE scores, which are less than five years old.

International applicants from non-English speaking countries are required to submit TOEFL scores of 80/550 (internet-based/paper-based test score scale) or above. Admitted international students with TOEFL scores between 80/550 and 90/600 will be required to take an English proficiency exam upon arrival at the university; in addition, they may be required to take additional courses to develop their language skills. English language courses required for international students do not apply to program credit hours. Admitted international students must submit an affidavit of financial support confirming adequate funding for their first year of study and a copy of their passport. Visa documents cannot be issued unless both the financial affidavit and passport are on file with the College of Architecture.

Although we encourage early submission, completed applications and all supporting documents must be received by the deadline for each program. Late applicants will be reviewed only if space is available.

For the graduate programs to achieve their objectives, it is necessary to restrict the number of students admitted. Admission to the graduate programs is limited by college requirements. All applicants are considered on a competitive basis, with every effort being made to select outstanding candidates.

Degrees Offered

- Master of Architecture (M. Arch.), Professional Degree (p. 194)
- Master of Landscape Architecture (M.L.A.), Professional Degree (p. 197)
- Master of Architecture/Master of Landscape Architecture (dual degree) (p. 201)
- Master of Science in Architecture (p. 202)
- Doctor of Philosophy in Architecture (p. 203)
- Doctor of Philosophy in Architecture with Specialization in History and Theory of Architecture (p. 204)
- Doctor of Philosophy in Architecture with Specialization in Technologies of the Built Environment (p. 205)

Course Descriptions

ARCH 500
Global Modernism
During the last one hundred years a number of cultural, economic, and social changes have moved architectural discourse and practice into a global network. This survey course focuses on the rise of new educational, financial, geo-political, professional, and technological scenarios that transformed architecture and urbanism from the end of World War One to the present. Canonical buildings and sites are discussed within the context of global modernism.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 501
Contemporary Architecture
This course investigates the state of contemporary architecture as represented by significant practices, buildings, theories, and criticisms. Themes to be considered include globalization, the role of digital design media, the ethics and aesthetics of sustainability, contemporary urbanism, new approaches to materials and structure, and recent interests in ornament and pattern-making. Current conditions will be related historically to postwar reactions to modernism and contextually to the social and technological shifts of recent decades. With a focus on primary readings and building documentation, the course places an emphasis on the great complexity of social, political, intellectual, and technological forces affecting design. Critical reading and writing skills will be emphasized.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 502
Advanced Topics in History and Theory I
Intended to build on the knowledge and abilities gained in the foundational architectural history and theory courses. This seminar focuses on advanced topics in history, theory, and criticism. Students select from varying and diverse topics such as urbanism, sustainability, design methodology, aesthetics, ethics and law, history of technology, and architecture in relation to other arts. Seminar may also offer intense focus on particular architects, periods, regions, or movements. Critical reading and writing skills will be emphasized. In addition, the advanced seminar will teach research skills, will expect the students to formulate and pursue original research topics, and will expect oral presentations of these projects. These abilities will be evaluated through in-class presentations and research papers.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 503
Advanced Topics in History and Theory II
Intended to build on the knowledge and abilities gained in the foundational architectural history and theory courses. This seminar focuses on advanced topics in history, theory, and criticism. Students select from varying and diverse topics such as urbanism, sustainability, design methodology, aesthetics, ethics and law, history of technology, and architecture in relation to other arts. Seminar may also offer intense focus on particular architects, periods, regions, or movements. Critical reading and writing skills will be emphasized. In addition, the advanced seminar will teach research skills, will expect the students to formulate and pursue original research topics, and will expect oral presentations of these projects. These abilities will be evaluated through in-class presentations and research papers.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 505
Urban Ecology
Students will develop a sensitivity to the environment in which architecture is created. Emphasis will be placed on an in-depth exposure to the integration of natural features of site, sustainable components of both natural and man-made systems, and the synergy of ecological design.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 506
Design Communications I: Units and Order
A comparative study of physical and digital media from the immediacy of the hand to the logical rigor of algorithmic design. Organizational systems and mapping strategies explored as craft is developed across a broad toolkit. Instruction in object-oriented thinking begins an introduction to computer science.
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 507
Design Communications II: Systems and Assemblages
The full design communication process, from contextual and programmatic analysis to the digital fabrication of a system of parts, will be introduced through a series of related studies. Computationally associative design methodologies will be utilized and continue the computer science introduction.
Prerequisite(s): [(ARCH 506)]
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 508
Design Communications III
Introduction to geospatial mapping, data modeling, and data visualization processes for research, analytics, and generative design. Basic data structures, algorithms, and design patterns advance students ability to construct digital tools and communicate complexity.
Prerequisite(s): [(ARCH 506)]
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 509
Topics in Advanced Technology
This research seminar examines advances in the technologies that affect the practice of architecture. The course examines leading technologies, processes, and applications, and their role in building design and production. The course will navigate the broad and varied materials related to advanced technologies in architecture by focusing on specific applications for specific projects. Students may select between varying and diverse topics offered by the faculty that may include building envelopes, architectural materials, building and environmental systems, advanced structural design, energy and sustainability, architectural acoustics and lighting, fabrication, and computer-aided design technologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 513
Mechanical and Electrical Building Systems for Architects I
Selection and design of building support systems: heating, ventilating, air conditioning, water supply, sanitary and storm drainage, power distribution, lighting, communications, and vertical transportation. Systems are analyzed for their effect on building form, construction cost, and operating efficiency.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 514
Mechanical and Electrical Building Systems for Architects II
Selection and design of building support systems: heating, ventilating, air conditioning, water supply, sanitary and storm drainage, power distribution, lighting, communications, and vertical transportation. Systems are analyzed for their effect on building form, construction cost, and operating efficiency.
Prerequisite(s): [(ARCH 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 520
Introduction to Urbanism
An immersion in the history, discourse, and culture of cities in the modern era with an emphasis on Chicago and a focus on the needs and influences surrounding urban growth, development, and culture. Readings, lectures, case studies, film screenings, field trips, and discussions will provide a basic set of conceptual and theoretical resources for understanding the origins and development of cities. This course will develop a context for understanding the role of design in shaping the urban environment.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 523
Master's Project Preparation: Research Analysis and Programming
Identification and development of the proposal for the master's project. Development of the project will include a comprehensive listing of all necessary program elements, research, analysis and selection of site, a statement of design parameters, project objectives, or similar project characteristics. Projects will be selected from eight areas of focus: sustainable cities, building delivery practices, community-based planning, research/history/theory, research/advanced technologies, housing and urban design, high-rise typology, and cultural institutions.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 541
Architecture Studio I: Elements
Introduction of fundamental architectural elements (walls, doors, windows, stairs, rooms) through research, precedent study, and related design assignments. Establishment of quality criteria and core communication skills (verbal, graphic, and written) allow studio members to detect and avoid chance and arbitrariness in order to arrive at rational clarity and intellectual order. Studio projects focus on deployment of fundamental architectural elements into a whole and unified small structure.
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 542
Architecture Studio II: House
The second semester of the Master of Architecture focuses on the development of the fundamental aspects of building (space, structure, and materials) which are explored through designing a small house. Students expand their notions of scale and context through the investigation of current issues, historical and contemporary precedents, and the careful analysis and documentation of a specific site within a neighborhood of the city. Through a series of assignments, the studio is guided step by step through an iterative design process that culminates in imagining the home of the future.
Prerequisite(s): [(ARCH 541)]
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 543
Architecture Studio III: Neighborhood
Students move beyond the single building and elements that make up the home to consider the spaces between buildings, infrastructural elements, and neighborhoods. More complex sites and programs are introduced through the study of mixed-use buildings with hybrid structures and projects comprised of multiple building elements. Research of neighborhood typologies culminate in an urban design study that becomes the basis for individual building designs. The introduction of sustainable design concepts and material selection increase the students understanding of the building as a whole and are precursor to the comprehensive building design studio. Finally, students explore the architect's role in the making of a neighborhood and end with a project considering the neighborhood of the future.
Prerequisite(s): [(ARCH 542)]
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 544
Architecture Studio IV: Institution
This studio is the last of the four milestones of the curriculum consisting sequentially of Element, House, Neighborhood, and Institution. As a bridge between the concerns of the neighborhood and the metropolitan scale issues to be encountered in the subsequent Cloud Studios, this studio will deal with problems, programs, and contexts that are unique to institutional architecture within the city and will challenge students to create forward-looking strategies for renewed civic and cultural development. Because this studio is the only required comprehensive studio for the Master of Architecture degree program, all students must demonstrate that they are capable of producing a single building project demonstrating the synthesis of ecological planning, programming and code analysis, structure, and building systems. Students will research and produce a building program based on the themes introduced in the studio sections consisting of all necessary code research, context documentation and analysis, building theme research, and logistics research. Project will vary by studio section.
Prerequisite(s): [(ARCH 543)]
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 545
Architecture Cloud Studio V: Metropolis
The cloud studio is a research-based design studio focused on investigating the complex forces that shape the built environment and proposing new strategies for urban development. The aim of the studio is to build a commentary and transformative agenda toward the future metropolis and to drive urban and architectural design solutions with the most advanced technologies and critical thought. The studio production is oriented toward the development of new strategies and future urban models with the aim of advancing the knowledge of relationships between urban thinking and materiality, technology, energy, ecology, emerging media, and socio-political and cultural concerns. Strong emphasis is put toward engagement with external parties and agencies to connect the academic environment with the professional practice and to promote cross-disciplinary collaboration. Students will be able to select from a variety of studio topics. Vertical studio integrating advanced BArch, MArch, MS, and PHD students. Open only to Architecture majors.
Prerequisite(s): [(ARCH 544)]
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 546
Architecture Cloud Studio VI: Metropolis
The design-based research studio is a continuation of the ARCH 545 research based design studio. It is focused on the development of the specific proposals based on the critical findings of ARCH 545. The aim of the studio is to develop formal solutions which address the complexities of modern metropolis and advance disciplinary knowledge at large. The studio production is oriented toward the development of projects in a variety of scales from large-scale master plans, urban designs, and landscape designs to new urban typologies and singular buildings, all of which can address a variety of the issues pertinent to the modern metropolis. The studios are formed in few thematic clusters which complement each other or serve as dialectical opposites. Each studio explores variety of techniques from parametric design, digital fabrication, model making, and advanced geospatial software to cultural and theoretical discourses. Vertical studio integrating advanced BArch, MArch, MLA, MS, and PHD students. Students will be able to select from varied studio topics. Open only to Architecture majors.
Prerequisite(s): [(ARCH 545)]
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 551
Design of Energy-Efficient Buildings I
Design criteria for achieving human performance goals in energy-efficient buildings, criteria for the exterior/interior environment, and criteria for architectural, mechanical, electrical and building system components. Building upon the fall course, various energy-conserving strategies shall be evaluated for achieving cost effective, energy-efficient design of a specific building type.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 552
Design of Energy-Efficient Buildings II
Design criteria for achieving human performance goals in energy-efficient buildings, criteria for the exterior/interior environment, and criteria for architectural, mechanical, electrical and building system components. Building upon the fall course, various energy-conserving strategies shall be evaluated for achieving cost effective, energy-efficient design of a specific building type.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 553
High-Rise Building Technology I
The course consists of presentations by specialists in the various technologies of high rise buildings including planning, financing, code reinforcement, materials, architecture, engineering, project management, construction, building management services, safety, and maintenance.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 554
High-Rise Building Technology II
The course consists of presentations by specialists in the various technologies of high rise buildings including planning, financing, code reinforcement, materials, architecture, engineering, project management, construction, building management services, safety, and maintenance.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 560
Integrated Building Delivery Practice/BIM
Architecture has always been a complex interdisciplinary business, where the management of allied professions and industry affiliates is critical to the success of any endeavor of significant scale. The introduction of BIM (Building Information Modeling) is an advance in project delivery tools which should be viewed as a multi-dimensional expansion of the mechanisms of management and accommodation of an ever-broadening range of participants in the organization of a project, allowing the development of a new delivery protocol, IBPD (Integrated Building Project Delivery). BIM is currently recognized as consolidating the basis for a range of functions including drawing, modeling, document management, clash detection, interdisciplinary coordination, estimating, scheduling, constructability review, production modularization, fabrication protocols, and for the analysis of myriad physical and proscriptive demands such as energy consumption, daylighting, code compliance, egress, circulation, and operation scenarios. The breadth of information embedded in a BIM model will require the emergence of facilitating professionals to an extent previously unknown in the practice and the industry. This course explores the state of the profession and the anticipated ramifications.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 561
Entrepreneurship and Innovation in Architecture
The course teaches future architects the practical aspects of entrepreneurial small business management, to develop a comprehensive opportunity assessment and to develop the skills necessary to improve the odds of success. The course will consider strategies to leverage limited resources for maximum effect. The course will also cover small organization and group behavior, performance, leadership, and motivation in small business settings and will focus on the owner/manager as the principal success factor in the context of a small organization. Emphasis is placed on the circumstances and opportunities of the professional practice of architecture: practice as profession, process, organization, business, and evolving models of practice are covered. The course also provides a series of concepts, frameworks, and heuristics that enable the entrepreneur to anticipate and deal with the challenges that accompany growth of an existing business. Cases, exercises, lectures, and speakers are used to focus on choosing opportunities, allocating resources, motivating employees, and maintaining control while not stifling innovation. A key component of the course is how to sustain entrepreneurial thinking in mid-sized ventures as they continue to grow.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 562
Planning Law and Land Policy
Since the introduction of basic zoning laws to the numbers and complexity of ordinances attached to any land parcel have proliferated to include those addressing land use, development, density, environmental concerns both on and off site, aesthetic mandates, energy use, quality of life concerns, and infrastructure development, the growing understanding that comprehensive and integrated systems must be managed across property lines to effect sustainable planning and communities will accelerate the number of prescriptive and policy ordinances enforced at the development of a parcel. Many agencies have further created extra-legal linkages between approvals for land development and the provision of social and ideological benefits to the community. The impact on the profession of architecture of the panoply of planning options and governmental goals is the result that the navigation of the system of mandated design determinates is one of the initial and potentially most creative acts in the process of project delivery. Project designers must understand the ramifications and trade-offs inherent in the system, especially in any attempt to achieve the best use of any parcel of land and position the most appropriate built environment.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 563
Introduction to Real Estate Finance Fundamentals
The Art of the Deal, with the emphasis on Art, is a term best positioning the financial structuring behind any project. The ability of the project team leader in integrated practice to understand and appreciate the motivations and opportunities inherent in the initiation of the project will be essential in guiding team decisions and maintaining a leadership position. The understanding of the financial underpinnings of a project is of paramount importance to those intending to actually engage the process of initiating and effecting a construction activity. The sources, costs, and sequence of funding, budgeting, cash flow, incentives options, and tax ramifications regarding a project are to be addressed as component knowledge to an understanding of integrated project management.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 564
Comprehensive Opportunity Assessment and Entrepreneurship Development Project/Practicum
Two options are available to the student for the acquisition and assimilation of the breadth of knowledge required to bring project ideas to fruition. The Comprehensive Development Project is a capstone effort which will demonstrate project concept, planning resolution, land acquisition strategies, estimating, scheduling, financial pro-forma, and value capture intents. The practicum would entail employment at a vetted office engaged in the actual process of project assembly. A position requiring a minimum of 20 hours per week, prior review and approval of the work plan, and submittal of documentation of the work undertaken would be required for this scenario. The ultimate objective is to provide a roadmap of the interaction between the architect-entrepreneur, market opportunities, and integrated building delivery practices which facilitate the development of student skills necessary to compete in a rapidly changing socio-economic environment. This course is designed to help students learn and use tools and frameworks to create, implement, and update a strategic plan to shape the future and guide an entrepreneurial organization on its path to success. This course will entail collaboration with real world organizations including city agencies, community development corporations, IIT Department of Community Affairs, or private developers.
Lecture: 6 **Lab:** 0 **Credits:** 6

ARCH 565
Construction and Project Management
The organization of deliverables from the multiple participants in a project plan, including estimating, quality control, value engineering, scheduling of work, conflict resolution, pay schedules, and project close-out and commissioning are essential to managing a building project. Many of these areas of endeavor are those most directly impacted by the developments addressed in Integrated Building Delivery Practice. This course will solidify the underpinnings and will amplify, where needed, the requisite understanding in these areas of the practice. The development of managerial skills requisite to the practice of this coordination and the basis of developing inter-professional relationships will be stressed throughout the incorporation of the technical methodologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 566
Entrepreneurial Design: Sector Studies/Case Studies
This course will be advanced as an independent study format. Each student will work independently to research a project option, or building type, and document the particular attributes of that case study which require specialized address. Case studies might be a particular business niche, such as land sub-divisions, condo conversions, change of use conversions, or build-to-suit options. The studies might pursue particular building types, social initiatives, historic restoration strategies, or even unique construction typologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 568
Architectural Practice
Lectures and practical problems dealing with specifications, specification writing, administration of construction, contracts, building law, and professional practice.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 570
Talking TALL I
Talking TALL I will fully examine the physical, environmental, and social sustainability implications of tall buildings at human, architectural, and urban scales in order to offer students extensive and in-depth knowledge and resources to investigate tall buildings and future cities. The aspects of TALL buildings covered in this course include their design principles, technologies, appropriateness to context, energy consumption, life-cycle considerations, natural ventilation, vertical greenery, facades, new typologies, and more. The aspects of TALL cities covered include an analysis of vertical urbanism vs. suburban sprawl, transportation and infrastructure implications, quality of life for residents in tall urban environments, etc., -- all ultimately with a view to a discourse on what should constitute a holistic vision of "sustainable vertical urbanism."
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 571
Talking TALL II
Talking TALL II will fully examine the physical, environmental, and social sustainability implications of tall buildings at human, architectural, and urban scales in order to offer students extensive and in-depth knowledge and resources to investigate tall buildings and future cities. The aspects of TALL buildings covered in this course include their design principles, technologies, appropriateness to context, energy consumption, life-cycle considerations, natural ventilation, vertical greenery, facades, new typologies, and more. The aspects of TALL cities covered include an analysis of vertical urbanism vs. suburban sprawl, transportation and infrastructure implications, quality of life for residents in tall urban environments, etc., -- all ultimately with a view to a discourse on what should constitute a holistic vision of "sustainable vertical urbanism." While Talking TALL I focuses mostly at the urban scale, Talking TALL II focuses more on the detailed building/technological scale.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 588
Thesis Preparation Seminar
The Master of Science in Architecture program positions its investigations in the liminal space between emerging forms of urbanization and existing concepts of architecture, landscape, and cities. Our goal is to develop new and better models for shaping socially, culturally, and ecologically sustainable environments. Thesis preparation seminars are conducted on thesis development with a thesis statement outlining an area of study or a problem that has consequences for contemporary architectural production at-large. Thesis development is parallel and complementary with the research-based design cloud studio ARCH 545 with Master of Science students focusing on the social and cultural aspect of research-based design developments. The seminar will focus on developing a bibliography, case studies of referential projects and built structures, and advanced research methods specifically tailored to the research interests of each student. Regular oral presentations will focus on development of thesis content, the use of media and rhetoric, and the didactic nature of disciplinary architectural communication. Open only to Architecture majors.
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 589
Pre-Thesis Seminar
The Master of Science program seeks to be synthetic and inter-disciplinary in its approach. In contrast to an increasingly compartmentalized design profession divided into disparate realms of expertise, the program endeavors to sharpen critical thinking through collaborative and experimental working processes. Thesis development is parallel and complementary with the design-based research cloud studio ARCH 546. The focus is on design-based research work understood both as an intellectual problem of exploring the relationship between design and theory for knowledge production and as a practical problem of the way that design research can affect architectural practice. The seminar is focused on the general development of thesis work specifically generating an overall thesis structure and opening chapters. By the end of the semester, a thesis advisory committee with a thesis chairman and two additional faculty members is assigned to each thesis student. Open only to Architecture majors.
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 590
Specialized Research and Thesis Development
Each thesis project must demonstrate an intellectual objective and an in-depth study that will contribute to the practice of architecture. The formulated problem should combine a theoretical search with the practical considerations of the profession. Research methods are identified that will provide the resources and information necessary for the design process. Post-occupancy building evaluations of similar problems are used to analyze technical assumptions, functional response and social reaction. (Credit: Variable)
Credit: Variable

ARCH 591
Research and Thesis
The thesis research and development of ARCH 591 is premised on the view that design and research activities are inseparable and that knowledge production (theory) and formal production (practice) are methodologically linked. Marking the transition between the academic and professional worlds, the thesis work is an opportunity for each student to define an individual position with regard to a specific aspect of architectural practice. It is intended that the thesis project looks upon architectural and urban designs as formal and theoretical elaborations of the design-based research cloud studio ARCH 546 as well as the collective outcome of socio-political forces analyzed during thesis research. Thesis work leads towards the final acceptance of the presentation materials by the advisory committee. The text, reductions of the drawings, and representations using various media are bound together in a hard-cover volume, which is deposited in the Graham Resource Center and the Galvin Library. Credits: Variable; minimum total eight semester hours. Open only to Architecture majors.
Credit: Variable

ARCH 593
Master's Project
The Masters Project is the culmination of both the two-year and three-year Master of Architecture curricula -- the synthesis of architectural study into an independent project. The Project is, most commonly, the design of a building or in-depth research about specific aspects of the built environment. Specialized research and design within a wide range of architectural problems include site selection, consideration of architectural context and environmental impacts, development of user function and space programs, and architectural planning and design. Aesthetic and visual aspects and the intellectual foundations of the problem are carefully considered, as well as the technical aspects in the selection and integration of structural and environmental systems. Successful Masters project proposals will be grouped into "Areas of Focus" studios. After final acceptance of the presentation materials by the faculty advisor and the "Area of Focus" teaching faculty, the text, reductions of the drawings, and model photographs are bound together, which are deposited in the GRC and the University's library.
Prerequisite(s): [(ARCH 523)]
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 594
Research Problems
Credit: Variable

ARCH 595
Research in Progress Forum
Research in Progress Forum presents students with opportunities (lectures and reading discussions) to engage with other researchers in the fields of architectural history/theory and technologies of the built environment.
Lecture: 0 **Lab:** 0 **Credits:** 0

ARCH 596
ARCH IPRO
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 597
Special Problems
Credit: Variable

ARCH 600
Continuance of Residence
Lecture: 0 **Lab:** 1 **Credits:** 1

ARCH 601
Doctoral Methodology Pre-Seminar
This course provides a foundation for doctoral students in the diversity of research paradigms in architecture. The first component is an introduction to philosophy of knowledge with an emphasis on architecture. The second component entails a critical review and evaluation of diverse research methodologies in current doctoral architectural research. It is intended to provide substantial information on research methodologies not covered in undergraduate and graduate education. In this course students will write a series of papers that critically review the course readings and discussions.
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 602
Crafting a Dissertation
This course provides a context in which doctoral students can formulate their dissertation proposals. Through reading and discussion of model research projects and methodological studies, students will examine the challenges and potentials of locating a dissertation topic, shaping a hypothesis, selecting methods and interpretive frameworks, conducting research, and articulating a compelling argument. The course addresses both pragmatic and intellectual aspects of research. A primary goal is the writing of a draft dissertation proposal as the basis for the Ph.D. comprehensive exam. The course will follow a seminar format requiring significant reading, writing, and class participation.
Prerequisite(s): [(ARCH 601)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ARCH 611
Seminar in Theory and Technology I
It will explore the history of modern architectural theory from the late seventeenth-century to 1975 with special regard to technology and its relationship to architectural culture. At times architectural theory forms a backdrop to architectural practice while seemingly taking little account of technological events. At other times technology and its material innovations change the very nature of architectural practice and its discourse. The course will consist of short lecture, presentations, and discussion.
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 612
Seminar in Theory and Technology II
It will form a continuation of ARCH 611 and consider the interface of theory and technology over the last thirty years. Students will take a more active role in tailoring their participation to advance their research in the dissertation and thesis topics they wish to pursue. Larger thematic issues of theory and technology will be considered within the richness of contemporary debates and competing interests. Students will present papers and a collective seminar document or publication will be produced.
Lecture: 0 **Lab:** 0 **Credits:** 3

ARCH 690
Research and Analysis Studio
Each research project must demonstrate an intellectual objective and an in-depth study that will contribute to the practice of architecture. The formulated problem should combine a theoretical search with the practical considerations of the profession. Research methods are identified that will provide the resources and information necessary for the design process. Post-occupancy building evaluations of similar problems are used to analyze technical assumptions, functional response, and social reaction.
Lecture: 0 **Lab:** 0 **Credits:** 6

ARCH 691
Doctoral Research
Credit: Variable

ARCH 801
Introduction to Architecture: Graduate Architetural Studio Preparatory
The emphasis of the course is on the fluid integration of manual and digital modes of representation into a cohesive process ? a skill set essential for navigating the architectural studio. Concepts and techniques covered will be the foundational skills of the architect; the various modes of freehand drawing, imaging, descriptive and analytic orthographic projection, and architectural model-making.
Lecture: 0 **Lab:** 0 **Credits:** 0

LA 501
History, Theory, and Criticism I: Landscape Architecture Theory
Inquiry into the texts and projects of contemporary landscape architecture situated within a framework of historical and canonical texts and projects.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 502
History, Theory, and Criticism II: Landscape Architectural History
The chronological history of designed landscapes with an emphasis on the emergence of the profession of landscape architecture in North America in the nineteenth and twentieth centuries.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 503
History, Theory, and Criticism IV: Advanced Contemporary Theory -- Case Studies
Twentieth century and contemporary landscape architecture is investigated through case studies including site visits to projects in the Chicago region.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 504
History, Theory, and Criticism III: Landscape Architecture Research Seminar
Advanced study of landscape architecture topics with emphasis on research methods, description, analysis, and criticism.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 514
Professional Practice of Landscape Architecture I: Entrepreneurship and Practice
Develop expertise in professional practice. Lectures, research assignments, and case studies will investigate practice models, proposals and contracts, schedules and budgets, project phases, project and client types, project team structure, the role of competitions, professional development, and licensure. In addition, the role of landscape architects, urban planners, real estate trusts, government agencies, developers, and others in directing the economic, professional, political, and socio-cultural concerns and responsibilities to initiate and manage landscapes will be investigated.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 516
Professional Practice of Landscape Architecture II: Landscape Architecture and Time
Investigations of gardens, landscapes, infrastructure, and cities as they are conceived, mature, and change over time. Study of landscapes designed for successional processes, weathering, biological growth and decay, seasonality, preservation and conservation of historic landscapes, and other topics.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 525
Design Media I: Drawing and Modeling the Landscape
Drawings (manual and digital) and models (physical and digital) will be employed to explore and interrogate landscape processes and envision ideas particular to landscape architecture such as mapping, time, movement, line, contour, texture, and materials, among others, while also developing a mastery of drawing conventions and media.
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 526
Design Media II: Digital Media
Using digital tools to clarify, conceptualize, represent, and communicate designed and engineered environments. A fluidity between critical, visual, and quantifiable digital techniques will be cultivated and will ground the management of information across software platforms.
Prerequisite(s): [(LA 525)]
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 527
Design Media III: Advanced Modeling and Fabrication-Dynamic Processes
Investigate advanced digital fabrication and modeling techniques necessary to understand complex three-dimensional surfaces, objects, and space, as well as dynamic landscape and urban processes. Modeling, rendering, scripting, and animation skills are used to conduct, generate, and communicate research.
Prerequisite(s): [(LA 525 and LA 526)]
Lecture: 3 **Lab:** 0 **Credits:** 3

LA 541
Landscape Architecture Studio I: Processes
Understanding the fundamental relationships of dynamic processes with an emphasis on representing time, movement, space, light, rhythms, shifting boundaries and enclosures, and physical materials of landscape.
Lecture: 0 **Lab:** 12 **Credits:** 6

LA 542
Landscape Architecture Studio II: Site and City
Continued development of the core tools of the discipline of landscape architecture focusing on the 21st century city. Rigorous site analysis will include emphasis on material, cultural, and ecological expression of city-scale networks and flows at the site scale. Design investigations will explore the site itself, its adjacent conditions, and the larger neighborhood or civic milieu.
Lecture: 0 **Lab:** 0 **Credits:** 6

LA 543
Landscape Architecture Studio III: Comprehensive Landscape Architecture
The integration of local ecologies, projected use, and the performance of ephemeral, semi-permanent, and permanent site interventions into cohesive and resilient design proposals for varied urban sites. Introduction to a wide range of site-specific professional design standards including the Americans with Disabilities Act and barrier-free regulations.
Prerequisite(s): [(LA 542)]
Lecture: 0 **Lab:** 0 **Credits:** 6

LA 544
Landscape Architecture Studio IV: Site, City, and Region
Development of landscape architecture as a multi-scalar framework for designing dynamic urban processes and sites. Emphasis on research and design strategies that focus on the region as an analytical lens for site-specific design.
Prerequisite(s): [(LA 541) OR (LA 543)]
Lecture: 0 **Lab:** 0 **Credits:** 6

LA 545
Landscape Architecture Studio V: Metropolis
The cloud studio is a research-based design studio focused on investigating the complex forces that shape the built environment and proposing new strategies for urban development. The aim of the studio is to build a commentary and transformative agenda toward the future metropolis and to drive urban, architectural and landscape design solutions with the most advanced technologies and critical thought. The studio production is oriented toward the development of new strategies and future urban models with the aim of advancing the knowledge of relationships between urban thinking and materiality, technology, energy, ecology, emerging media, and socio-political and cultural concerns. Strong emphasis is put toward engagement with external parties and agencies to connect the academic environment with the professional practice and to promote cross-disciplinary collaboration. Students will be able to select from a variety of studio topics. Vertical studio integrating advanced BArch, MArch, MS, MLA, and PHD students.
Prerequisite(s): [(LA 544)]
Lecture: 0 **Lab:** 0 **Credits:** 6

LA 546
Landscape Architecture Studio VI: Metropolis
The design-based research studio is a continuation of the LA 545 research-based design studio. It is focused on the development of the specific proposals based on the critical findings of LA 545. The aim of the studio is to develop formal solutions which address the complexities of modern metropolis and advance disciplinary knowledge at large. The studio production is oriented toward the development of projects in a variety of scales from large-scale master plans, urban designs, and landscape designs to new urban typologies and singular buildings, all of which can address a variety of the issues pertinent to the modern metropolis. The studios are formed in few thematic clusters which complement each other or serve as dialectical opposites. Each studio explores variety of techniques from parametric design, digital fabrication, model making, and advanced geospatial software to cultural and theoretical discourses. Vertical studio integrating advanced BArch, MArch, MLA, MS, and PHD students. Students will be able to select from varied studio topics.
Prerequisite(s): [(LA 545)]
Lecture: 0 **Lab:** 0 **Credits:** 6

LA 565
Ecology and Materials Workshop I: Plants and Planting
The plants of the Western Great Lakes Basin, emphasizing both prominent native and commercially available species. Understanding and identifying species as found within typical plant communities. Familiarization with plant physiology as determined by climate, geology, topography, hydrology, soils, wildlife, and disturbances.
Lecture: 2 **Lab:** 2 **Credits:** 3

LA 566
Ecology and Materials Workshop II: Earthworks and Infrastructures
The qualities and characteristics of landscape materials with emphasis on a quantitative and interrelated understanding of the design of landform (grading) and water. Covers the influence of climate, geology, soils, hydrology, and disturbances on the design of a site's constituent elements including paths and streets, infrastructure, plants, and water.
Lecture: 2 **Lab:** 2 **Credits:** 3

LA 567
Ecology and Materials Workshop III: Planting Design and Construction
Advanced understanding of planting typologies, the history of plants in design, and the preparation of planting construction documentation augmented by frequent investigations and analysis of built landscapes in the Chicago region.
Lecture: 2 **Lab:** 2 **Credits:** 3

LA 568
Ecology and Materials Workshop IV: Constructing the Urban Environment
Techniques and technologies to analyze, construct, remediate and/or restore urban sites including those that have been subjected to complex human disturbances such as landfills and brownfields. Includes special needs construction practices such as structured soils, phytoremediation, green roofs, and rooftop gardens.
Lecture: 2 **Lab:** 2 **Credits:** 3

LA 597
Special Problems
Special problems in landscape architecture. For students in the master program in landscape architecture only.
Credit: Variable

Master of Architecture - Professional Degree

The Master of Architecture professional degree serves those students seeking a consummate professional education. The degree is accredited by the National Architectural Accrediting Board (NAAB), and is a necessary component for licensure in the field.

The College of Architecture's graduate professional Master of Architecture degree program emphasizes the integration of architectural design, theory, and technology. Through rigorous work and critical thought, the college promotes innovation and underscores refinement with the objective of developing outstanding proficiency in the practice of architecture.

The college draws strength from its legacy of Mies van der Rohe, as well as from its own contributions to modern theory and practice. Our argument is that the poetics of space are inseparable from the practical and significant understanding of materials and fabrication. The strength of the curriculum lies in rigorously unfolding the implications of this position.

Our location in Chicago is central to our understanding of architecture as an urban art, which is greatly enriched by the vibrant culture of our city and the influence of its progressive and global architectural practices.

Our mission is to teach design excellence and technical expertise, and to foster an understanding of the role of the architect in society as an ethical, insightful, and informed leader. We believe that society sustains and enriches itself through thoughtful planning and careful work, and we regard the architect as the central figure who is best able to synthesize the natural and man-made in the creation of a more humane built environment.

The curriculum addresses principles of design concepts, materials, construction, systems, planning, professional practice, history and visual judgment, which are fundamental for the development of the creative process. The curriculum is progressive with required core coursework offering foundation knowledge, skills and vocabulary, while upper-level study seeks a broader understanding of architecture by combining theoretical exploration with practical considerations.

Master of Architecture with Advanced Standing

Candidates who hold a B.A. or B.S. in Architecture (a pre-professional program from an NAAB-recognized school in the U.S.) or international students holding a professional degree from outside the U.S.; and who have completed the equivalent of the first year's required courses, may qualify for up to one year of advanced standing in the professional degree program. Admission with advanced standing may allow the candidate to complete the Master of Architecture degree in as few as two years (four semesters), depending on prior preparation. Candidates may be asked to provide additional evidence on their previous coursework, including projects and course syllabi, to determine eligibility for advanced standing. Candidates will be notified upon admission as to their qualification for advanced standing. International students with a Bachelor of Architecture degree (or equivalent) who wish to pursue an NAAB-accredited program to be eligible for licensure in the United States should apply to the Master of Architecture with Advanced Standing.

Curriculum and Admission Requirements

The Master of Architecture professional degree program requires a bachelor's degree in any discipline from an accredited university.

For holders of a bachelor's degree outside of the field of architecture, who satisfy the prerequisites for admission, the course of study will be three years (six semesters) in length and 102 credit hours. For candidates who hold a B.A. or B.S. in Architecture (a pre-professional program from an NAAB-recognized school if from the U.S.) or international students with a Bachelor of Architecture degree (or equivalent), who satisfy the prerequisites for admission, the course of study may be reduced to a minimum of two years (four semesters) in length and 66 credit hours, as required of graduate students by the university, and based on the number of credits received for advanced standing. Candidates will be notified of their program requirements at the time of admission.

To be admitted without conditions to the professional degree program, an applicant is required to possess the following:

1. An understanding of basic systems and analytical procedures, including mechanics, heat transfer, light and sound, as demonstrated through the successful completion of a college-level physics course equivalent to IIT's PHYS 200;
2. An understanding of basic mathematical principles and analytical procedures, including algebra, geometry, and trigonometry, as demonstrated through the successful completion of a college-level mathematics equivalent to IIT's MATH 122;
3. A basic ability to produce freehand drawings of architectural forms and spaces, as demonstrated by the successful completion of one college-level drawing course or by portfolio submissions;
4. A basic understanding of design, as demonstrated by the successful completion of one college-level design course or by portfolio submissions;
5. An equivalent of 20 credit hours of liberal arts and humanities.

Candidates admitted with deficiencies in any of these prerequisites must fulfill them before matriculation. These prerequisite courses do not apply to program credit hours. Applicants must have a college grade point average of 3.0/4.0.

Degree Requirements

As required by the university, graduate students must maintain a 3.0 or "B" grade point average in their program of study. The College of Architecture also requires this as part of the Master of Architecture degree requirements. Within the college, particular emphasis is placed on the studio as the forum where aspects of the curriculum are synthesized. Candidates must pass each studio course before continuing to the next studio in the sequence. Students may receive a single "C" in a studio, if maintaining the required "B" average. However, if a student receives a second "C" in studio coursework, they will be subject to dismissal from the program. Students may remediate this situation by repeating the coursework and achieving a higher letter grade, or enrolling in a remedial studio. The additional credits required for the additional studio cannot be counted toward their program of study.

In addition to the curricular requirements for the degree, there are several milestones that have been integrated throughout the coursework to ensure a student's successful completion and comprehension of the concepts and material. Each student's progress will be evaluated by an independent panel of faculty prior to their continuation, and eventual completion, of the program.

There are a wide variety of electives available not only in the College of Architecture, but also in the university's Armour College of Engineering, Institute of Design, and Stuart School of Business. If the student has previously taken courses that duplicate curriculum requirements, appropriate electives may be substituted. English language courses required for international students do not apply to program credit hours. Master of Architecture students wishing to accomplish a master's thesis as part of the post-professional Master of Science in Architecture program may petition for dual enrollment.

M.Arch. Curriculum

			Year 1
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 485	3	ARCH 486	3
ARCH 500	3	ARCH 501	3
ARCH 506	3	ARCH 507	3
ARCH 541	6	ARCH 542	6
		Architecture Elective	3
	15		18

			Year 2
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 505	3	ARCH 502 or 503	3
ARCH 508	3	ARCH 514	3
ARCH 513	3	ARCH 544	6
ARCH 520	3	ARCH 568	3
ARCH 543	6	Materials Elective	3
	18		18

			Year 3
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 545	6	ARCH 546	6
ARCH 560, 561, 562, 563, or 565	3	Architecture Elective	3
ARCH 502 or 503	3	Architecture Elective	3
Architecture Elective	3	Architecture Elective	3
Architecture Elective	3		
	18		15

Total Credit Hours: 102

M.Arch. with Advanced Standing Curriculum

			Year 1
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 485	3	ARCH 486	3
ARCH 500	3	ARCH 501	3
ARCH 508	3	ARCH 514	3
ARCH 513	3	ARCH 544	6
ARCH 543	6	ARCH 568	3
	18		18
			Year 2
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 520	3	ARCH 502 or 503	3
ARCH 545	6	ARCH 546	6
ARCH 560, 561, 562, 563, or 565	3	Architecture Elective	3
Architecture Elective	3	Architecture Elective	3
	15		15

Total Credit Hours: 66

Master of Landscape Architecture

More than ever, the world needs more informed, more innovative, more critically involved landscape architects. Global population growth, changing climate, and continued depletion of natural resources question historical planning and design models. Landscape architects have emerged among design professionals to lead in the reclamation, organization, and understanding of our cities to meet these 21st century challenges. Among American cities, Chicago presents unique opportunities to test and celebrate the potential of urban environments to transform these conditions of crisis to promise, neglect to value, banality to beauty.

Chicago is geographically positioned within the Great Lakes Basin, where twenty percent of the world's fresh water supply is both a vital natural resource and an economic catalyst for the mega-region. While Chicago enjoys the legacy of a world-class park system sponsored by the 1893 Columbian Exposition, it is steadily being transformed by a set of contemporary projects and urban policies that signal the emergence of Chicago's 21st century landscape as a rigorous laboratory for global cities.

Additional Admission Requirements

To be admitted without conditions to the Master of Landscape Architecture program, an applicant is required to have prior college-level coursework in freehand drawing, biology, and earth science (geology, physical geography, hydrology, etc.). Candidates lacking these prerequisites may be admitted on the condition that they complete the required coursework before enrolling. Candidates will be notified upon admission of their program of study, which is determined by prior academic training and professional experience, as well as portfolio content.

Master of Landscape Architecture

Required Courses		(75)
LA 501	History, Theory, and Criticism I: Landscape Architecture Theory	3
LA 502	History, Theory, and Criticism II: Landscape Architectural History	3
LA 503	History, Theory, and Criticism IV: Advanced Contemporary Theory -- Case Studies	3
LA 504	History, Theory, and Criticism III: Landscape Architecture Research Seminar	3
LA 514	Professional Practice of Landscape Architecture I: Entrepreneurship and Practice	3
LA 516	Professional Practice of Landscape Architecture II: Landscape Architecture and Time	3
LA 525	Design Media I: Drawing and Modeling the Landscape	3
LA 526	Design Media II: Digital Media	3
LA 527	Design Media III: Advanced Modeling and Fabrication-Dynamic Processes	3
LA 541	Landscape Architecture Studio I: Processes	6
LA 542	Landscape Architecture Studio II: Site and City	6
LA 543	Landscape Architecture Studio III: Comprehensive Landscape Architecture	6
LA 544	Landscape Architecture Studio IV: Site, City, and Region	6
LA 545	Landscape Architecture Studio V: Metropolis	6
LA 546	Landscape Architecture Studio VI: Metropolis	6
LA 565	Ecology and Materials Workshop I: Plants and Planting	3
LA 566	Ecology and Materials Workshop II: Earthworks and Infrastructures	3
LA 567	Ecology and Materials Workshop III: Planting Design and Construction	3
LA 568	Ecology and Materials Workshop IV: Constructing the Urban Environment	3
Elective Courses		(15)
Select 6 credit hours of Landscape Architecture electives [1]		6
Select 9 credit hours of Landscape Architecture/Architecture electives [2]		9
Total Credit Hours		90

1. Electives may be chosen from any LA 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.
2. Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.

Master of Landscape Architecture with Advanced Standing

Required Courses		(45)
LA 501	History, Theory, and Criticism I: Landscape Architecture Theory	3
LA 503	History, Theory, and Criticism IV: Advanced Contemporary Theory -- Case Studies	3
LA 516	Professional Practice of Landscape Architecture II: Landscape Architecture and Time	3
LA 525	Design Media I: Drawing and Modeling the Landscape	3
LA 541	Landscape Architecture Studio I: Processes	6
LA 544	Landscape Architecture Studio IV: Site, City, and Region	6
LA 545	Landscape Architecture Studio V: Metropolis	6
LA 546	Landscape Architecture Studio VI: Metropolis	6
LA 565	Ecology and Materials Workshop I: Plants and Planting [1]	3
LA 567	Ecology and Materials Workshop III: Planting Design and Construction [1]	3
LA 568	Ecology and Materials Workshop IV: Constructing the Urban Environment	3
Elective Courses		(15)
Select 6 credit hours of Landscape Architecture electives [2]		6
Select 9 credit hours of Landscape Architecture/Architecture electives [3]		9
Total Credit Hours		60

1. Students with a B.L.A. may substitute Landscape Architecture/Architecture electives for LA 565 and LA 567.
2. Electives may be chosen from any LA 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.
3. Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.

Electives

Media

- GIS
- Flash
- Animation
- Parametric (Revit)

History and Theory

- Specific designers, periods, themes

Current electives

- Urban planning

Research

- As per individual student and faculty interests

Master of Landscape Architecture Curriculum

			Year 1
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
LA 501	3	LA 502	3
LA 525	3	LA 526	3
LA 541	6	LA 542	6
LA 565	3	LA 566	3
	15		15
			Year 2
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
LA 504	3	LA 503	3
LA 527	3	LA 514	3
LA 543	6	LA 544	6
LA 567	3	LA 568	3
	15		15
			Year 3
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
LA 516	3	LA 546	6
LA 545	6	Landscape Architecture Elective[1]	3
Landscape Architecture Elective[1]	3	Landscape Architecture/Architecture Elective[2]	3
Landscape Architecture/Architecture Elective[2]	3	Landscape Architecture/Architecture Elective[2]	3
	15		15

Total Credit Hours: 90

1. Electives may be chosen from any LA 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.
2. Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.

Master of Landscape Architecture with Advanced Standing Curriculum

			Year 1
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
LA 501	3	LA 503	3
LA 525	3	LA 544	6
LA 541	6	LA 568	3
LA 565[1]	3	Landscape Architecture/Architecture Elective[2]	3
	15		15

			Year 2
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
LA 516	3	LA 546	6
LA 545	6	Landscape Architecture Elective[3]	3
LA 567[1]	3	Landscape Architecture/Architecture Elective[2]	3
Landscape Architecture Elective[3]	3	Landscape Architecture/Architecture Elective[2]	3
	15		15

Total Credit Hours: 60

1. Students with a B.L.A. may substitute landscape architecture/architecture electives for LA 565 and LA 567.
2. Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.
3. Electives may be chosen from any LA 400- or 500-level course with adviser approval, subject to 400-level course limit restrictions.

Master of Landscape Architecture/Master of Architecture

The Master of Architecture/Master of Landscape Architecture (M.Arch./M.L.A.) dual degree has been shaped in recognition of the fact that in the best circumstances, architecture and landscape work in synthesis to shape our built environment. This newly created dual degree program provides core knowledge in both fields, while also emphasizing their shared territories and concerns, and ultimately preparing students to engage with the full complexity of the contemporary metropolis. By bringing the Master of Landscape Architecture and Master of Architecture degrees together, we embrace the integrative thinking that will address the challenges and opportunities set before designers of the 21st century.

Master of Architecture/Master of Landscape Architecture Curriculum

			Year 1
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 500	3	ARCH 485	3
ARCH 505	3	ARCH 508	3
ARCH 541	6	ARCH 542	6
ARCH 506 or LA 525	3	LA 502	3
		LA 566	3
	15		18
			Year 2
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 403	3	ARCH 404	3
ARCH 486	3	ARCH 501	3
ARCH 543	6	ARCH 544	6
LA 565	3	LA 568	3
		Landscape Architecture Elective	3
	15		18
			Year 3
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 502	3	ARCH 509	3
LA 543	6	ARCH 565	3
LA 567	3	LA 503	3
LA 501 or Landscape Architecture Elective	3	LA 544	6
		Landscape Architecture Elective	3
	15		18
			Year 4
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**
ARCH 520	3	ARCH 593	6
ARCH 523	3	ARCH 560	3
LA 545	6	Landscape Architecture Elective	3
LA 514, ARCH 561, ARCH 562, or ARCH 563	3	Architecture Elective	3
Architecture Elective	3		
	18		15

Total Credit Hours: 132

Master of Science in Architecture - Post-Professional Degree

The Master of Science in Architecture is a three semester program (including one summer semester) that allows students holding NAAB-accredited B.Arch. and M.Arch. degrees (or equivalent international degrees) to earn a master's degree with a research focus by continuing their studies. For some students the program may also lead to further studies and research in the Ph.D. in Architecture program.

The Master of Science in Architecture program seeks to be synthetic and inter-disciplinary in its approach, and endeavors to sharpen critical thinking through collaborative and experimental working processes. The program provides the intellectual climate and infrastructure to explore the forces that shape the contemporary built environment, subsequently developing, by means of design, alternative models and new insights to devise a transformative impact on the global cities.

The intensive three-semester program is structured around two design-based research studios, an individual or collective thesis project, history and theory seminars, and elective classes. The college's colloquia, lectures, and exhibitions expand upon and augment the curriculum.

Admission and Curriculum Requirements

Candidates for the post-professional Master of Science in Architecture must hold an accredited Bachelor of Architecture (B.Arch.) or Master of Architecture (M.Arch.) as a professional degree from an NAAB-accredited institution if earned within the U.S. International applicants must hold a Bachelor of Architecture or Master of Architecture degree or equivalent and be eligible for licensure in their home country.

In addition to the standard requirements for graduate admission, a personal interview with the director of the degree program is highly recommended. The program of study includes a minimum of 32 credit hours, of which at least 5 credit hours are in ARCH 591. Students entering the post-professional degree program should develop a detailed outline of their thesis project for approval by the director of thesis programs and their thesis adviser. The program of study for each student is developed individually with the thesis adviser. Study begins with investigation and analysis for the thesis under the direction of the adviser. By the second semester, a thesis committee of three faculty members oversees the work being produced. Students are required to take advanced courses related to their specialized areas of interest.

The final semester of study concludes the entire thesis project in writing, analysis, programming, and design. Thesis studies should offer the graduate a higher level of professionalism, significantly evolving one's career and the ability to make special contributions to the field.

Required Courses		(18)
ARCH 545	Architecture Cloud Studio V: Metropolis	6
ARCH 546	Architecture Cloud Studio VI: Metropolis	6
ARCH 588	Thesis Preparation Seminar	3
ARCH 589	Pre-Thesis Seminar	3
Elective Courses		(9)
Select 9 credit hours in any ARCH 400- or 500-level course [1]		9
Thesis Research		(5)
ARCH 591	Research and Thesis	5
Total Credit Hours		32

[1] Course selection is pending adviser approval and is subject to 400-level credit limit restrictions.

Curriculum

					Year 1
Semester 1	**Credit Hours**	**Semester 2**	**Credit Hours**	**Summer**	**Credit Hours**
ARCH 545	6	ARCH 546	6	ARCH 591	2
ARCH 588	3	ARCH 589	3		
Architecture Elective	3	ARCH 591	3		
Architecture Elective	3	Architecture Elective	3		
	15		15		2

Total Credit Hours: 32

Doctor of Philosophy in Architecture

52 credit hours beyond the master's degree
Written qualifying examination
Comprehensive examination
Dissertation and oral defense

The Doctor of Philosophy (Ph.D.) in Architecture program is for those individuals who desire to pursue careers in academia and/or in research-based professional practice. As the most advanced academic degree, the Ph.D. recognizes both the highest level of expertise and the production of significant novel work. The program demands a deep understanding of architecture's history and its contemporary intellectual terrain, a command of advanced research methodologies, and a commitment to critical inquiry that extends its frontiers.

The program begins with advanced coursework and culminates in a dissertation that is the result of extensive, original, and rigorous research and thought. The Ph.D. program grows out of the school's collective commitment to progressive research that is grounded in the realities of the workplace and devoted to contesting existing values and ideologies. Doctoral students will participate in the experiments of design studios and will later help guide these efforts in mentoring roles, helping to shape the debate within the college through their involvement in the college's "cloud studio."

Admission Requirements

An applicant to the doctoral program must hold a professional Master of Architecture degree (M.Arch.) from an NAAB-accredited U.S. university or the equivalent. Candidates who have not completed the required professional M.Arch. degree may apply for either the Master of Architecture or the Master of Science in Architecture program at Illinois Institute of Technology to fulfill that requirement, as a non-terminal program of studies preparatory for the doctoral program.

The applicant should meet all entrance requirements of the university's Graduate College, plus a minimum cumulative grade point average of 3.5 on a 4.0 scale, a TOEFL score of at least 80/550, and at least three letters of recommendation from immediate supervising professors. The applicant should also submit a statement of purpose indicating a subject of study or research work and should provide a portfolio demonstrating the qualities of his or her accomplishments and expertise.

Degree Requirements

The program requires a minimum of 52 credit hours usually completed in three-and-a-half to four years beyond the M.Arch. degree. The majority of the coursework will be selected from the curriculum with the College of Architecture, though students are encouraged to have their research find connections to other doctoral programs at the university.

Upon completion of the first academic year, the candidate will be required to pass a written qualifying examination before he or she will officially be admitted to Ph.D. candidacy. At the end of the program, the candidate will take a final examination which will consist of an oral presentation and defense of of the dissertation. Current areas of study include high-rise and long-span buildings, technology applications, energy conscious design, emerging urbanisms, housing, history/theory, and advanced computer applications. Work for the Ph.D. must be completed within six years after admission to doctoral candidacy.

Curriculum

The program requires a minimum of 52 credit hours, usually completed in three-and-a-half to four years beyond the M.Arch. degree. Students must complete at least 24 credit hours of dissertation research courses. A maximum of 12 credit hours of 400-level credit is allowed.

Elective Courses		(28)
Select 28 credit hours [1]		28
Ph.D. Research		(24)
ARCH 691	Doctoral Research [2]	24
Master's Transfer Coursework		(32)
A maximum of 32 credit hours may be transferred from master's degree		32
Total Credit Hours		84

1. Students may choose from 400-level or above ARCH, AURB, or LA courses, as well as the following courses from other university departments: CAE 597, ID 598, MMAE 597, or PHIL 597.
2. CAE 691, ID 691, and MMAE 691 credits will also be accepted towards Ph.D. research hour requirements.

Doctor of Philosophy in Architecture with Specialization in History and Theory of Architecture

52 credit hours beyond the master's degree (master's degree required)
Written qualifying examination
Comprehensive examination
Dissertation and oral defense
Reading knowledge of two foreign languages (generally German, French, or Italian)

The Doctor of Philosophy (Ph.D.) in Architecture program is for those individuals who desire to pursue careers in academia and/or in research-based professional practice. As the most advanced academic degree, the Ph.D. recognizes both the highest level of expertise and the production of significant novel work. The program demands a deep understanding of architecture's history and its contemporary intellectual terrain, a command of advanced research methodologies, and a commitment to critical inquiry that extends its frontiers.

The program begins with advanced coursework and culminates in a dissertation that is the result of extensive, original, and rigorous research and thought. The Ph.D. program grows out of the school's collective commitment to progressive research that is grounded in the realities of the workplace and devoted to contesting existing values and ideologies. Doctoral students will participate in the experiments of design studios and will later help guide these efforts in mentoring roles, helping to shape the debate within the college through their involvement in the college's "cloud studio."

Admission Requirements

An applicant to the doctoral program must hold a professional Master of Architecture degree (M.Arch.) from an NAAB-accredited U.S. university or the equivalent. Candidates who have not completed the required professional M.Arch. degree may apply for either the Master of Architecture or the Master of Science in Architecture program at Illinois Institute of Technology to fulfill that requirement, as a non-terminal program of studies preparatory for the doctoral program.

The applicant should meet all entrance requirements of the university's Graduate College, plus a minimum cumulative grade point average of 3.5 on a 4.0 scale, a TOEFL score of at least 80/550, and at least three letters of recommendation from immediate supervising professors. The applicant should also submit a statement of purpose indicating a subject of study or research work and should provide a portfolio demonstrating the qualities of his or her accomplishments and expertise.

Degree Requirements

The program requires a minimum of 52 credit hours usually completed in three-and-a-half to four years beyond the M.Arch. degree. The majority of the coursework will be selected from the curriculum with the College of Architecture, though students are encouraged to have their research find connections to other doctoral programs at the university.

Upon completion of the first academic year, the candidate will be required to pass a written qualifying examination before he or she will officially be admitted to Ph.D. candidacy. At the end of the program, the candidate will take a final examination which will consist of an oral presentation and defense of of the dissertation. Current areas of study include high-rise and long-span buildings, technology applications, energy conscious design, emerging urbanisms, housing, history/theory, and advanced computer applications. Work for the Ph.D. must be completed within six years after admission to doctoral candidacy.

Curriculum

All students will enter the program with a master's degree, hence the minimum credit hours of Ph.D. study is 52. The first doctoral methodology course (ARCH 601) is taken in the first semester of the first year; the second doctoral methodology course (ARCH 602) is directed to the preparation of the comprehensive exam proposal.

Required Courses		(18)
ARCH 500	Global Modernism	3
ARCH 501	Contemporary Architecture	3
ARCH 502	Advanced Topics in History and Theory I	3
ARCH 503	Advanced Topics in History and Theory II	3
ARCH 601	Doctoral Methodology Pre-Seminar	3
ARCH 602	Crafting a Dissertation	3
Electives		(18)
Select 18 credit hours [1]		18
Ph.D. Research		(16)
ARCH 691	Doctoral Research	16

Master's Transfer Coursework	(32)
A maximum of 32 credit hours may be transferred from master's degree	32
Total Credit Hours	84

[1] Electives will be tailored to the student's particular field of study. For instance, a student working on the social dimension of architectural thought might take higher level courses in the social sciences or humanities. Electives include the special projects or directed readings course (ARCH 597). The College of Architecture will also accept the following courses from other university departments: CAE 597, CAE 691, ID 598, ID 691, MMAE 597, MMAE 691, PHIL 597.

Doctor of Philosophy in Architecture with Specialization in Technologies of the Built Environment

52 credit hours beyond the master's degree
Written qualifying examination
Comprehensive examination
Dissertation and oral defense

The Doctor of Philosophy (Ph.D.) in Architecture program is for those individuals who desire to pursue careers in academia and/or in research-based professional practice. As the most advanced academic degree, the Ph.D. recognizes both the highest level of expertise and the production of significant novel work. The program demands a deep understanding of architecture's history and its contemporary intellectual terrain, a command of advanced research methodologies, and a commitment to critical inquiry that extends its frontiers.

The program begins with advanced coursework and culminates in a dissertation that is the result of extensive, original, and rigorous research and thought. The Ph.D. program grows out of the school's collective commitment to progressive research that is grounded in the realities of the workplace and devoted to contesting existing values and ideologies. Doctoral students will participate in the experiments of design studios and will later help guide these efforts in mentoring roles, helping to shape the debate within the college through their involvement in the college's "cloud studio."

Admission Requirements

An applicant to the doctoral program must hold a professional Master of Architecture degree (M.Arch.) from an NAAB-accredited U.S. university or the equivalent. Candidates who have not completed the required professional M.Arch. degree may apply for either the Master of Architecture or the Master of Science in Architecture program at Illinois Institute of Technology to fulfill that requirement, as a non-terminal program of studies preparatory for the doctoral program.

The applicant should meet all entrance requirements of the university's Graduate College, plus a minimum cumulative grade point average of 3.5 on a 4.0 scale, a TOEFL score of at least 80/550, and at least three letters of recommendation from immediate supervising professors. The applicant should also submit a statement of purpose indicating a subject of study or research work and should provide a portfolio demonstrating the qualities of his or her accomplishments and expertise.

Degree Requirements

The program requires a minimum of 52 credit hours usually completed in three-and-a-half to four years beyond the M.Arch. degree. The majority of the coursework will be selected from the curriculum with the College of Architecture, though students are encouraged to have their research find connections to other doctoral programs at the university.

Upon completion of the first academic year, the candidate will be required to pass a written qualifying examination before he or she will officially be admitted to Ph.D. candidacy. At the end of the program, the candidate will take a final examination which will consist of an oral presentation and defense of of the dissertation. Current areas of study include high-rise and long-span buildings, technology applications, energy conscious design, emerging urbanisms, housing, history/theory, and advanced computer applications. Work for the Ph.D. must be completed within six years after admission to doctoral candidacy.

Specialization in Technologies of the Built Environment

Architecture is a discipline encompassing both theory and practice. Engineering is a science applied to many industries of design and the construction trades, including energy systems, materials, structural efficiencies, acoustics, lighting, etc. Thus the professional reach of the two fields overlap in many ways. This joint specialization between the College of Architecture and the Department of Civil, Architectural, and Environmental Engineering provides a new pathway for qualified architecture and engineering students with suitable backgrounds to pursue doctoral research in various fields of building technologies, which span subjects including building physics, architecture, structural engineering, design, and others.

Curriculum

The program requires a minimum of 52 credit hours, usually completed in three-and-a-half to four years beyond the M.Arch. degree, which will include 6 credit hours of core courses. Another 6 credit hours will be chosen from a list of courses, depending on the student's dissertation research interests. Students must also complete at least 24 credit hours of dissertation research courses (ARCH 691 or CAE 691).

Required Courses			(12)
CAE 513	Building Science		3
ARCH 601	Doctoral Methodology Pre-Seminar		3
Select a minimum of two courses from the following:			6
CAE 502	Acoustics and Lighting	3	
CAE 521	Building Illumination Design	3	
CAE 524	Building Enclosure Design	3	
CAE 553	Measurement and Instrumentation in Architectural Engineering	3	
ENVE 576	Indoor Air Pollution	3	
ARCH 485	Structures I: Structural Analysis -- The System	3	
or ARCH 486	Structures II: Building Design		
ARCH 487	Eco Structures	3	
ARCH 488	Long-Span and Special Structures	3	
ARCH 508	Design Communications III	3	
ARCH 509	Topics in Advanced Technology	3	
ARCH 551	Design of Energy-Efficient Buildings I	3	
or ARCH 552	Design of Energy-Efficient Buildings II		
ARCH 602	Crafting a Dissertation	3	
Elective Courses			(16)
Select 16 credit hours [1]			16
Ph.D. Research			(24)
ARCH/CAE 691	Doctoral Research		24
Master's Transfer Coursework			(32)
A maximum of 32 credit hours may be transferred from master's degree			32
Total Credit Hours			84

1 Elective coursework should be taken within the student's field of concentration and/or to supplement their research interests. Courses within ARCH, CAEE, MMAE, and a number of other departments are allowed but are subject to adviser approval.

College of Science

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College of Science traces its roots to the Lewis Institute, founded in 1895, and to Armour Institute of Technology, founded in 1892. The college offers more than 90 rigorous and relevant programs in mathematics and the sciences at the undergraduate and graduate level (including master's, professional master's, and Ph.D.) through six departments: applied mathematics; biology; chemistry; computer science; mathematics and science education; and physics.

Applied Mathematics

Joint Degree Programs

Biology

Chemistry

Certificates

Computer Science

- Master of Computer Science with specialization in: (p. 268)

  Business
  Computational Intelligence
  Cyber-Physical Systems
  Data Analytics
  Database Systems
  Distributed and Cloud Computing
  Education
  Finance
  Information Security and Assurance
  Networking and Communications
  Software Engineering

- Master of Science in Computer Science (p. 277)
- Doctor of Philosophy in Computer Science (p. 280)

Joint Degree Programs

- Master of Data Science (with Applied Mathematics) (p. 273)
- Master of Telecommunications and Software Engineering (with Electrical and Computer Engineering) (p. 274)
- Master of Science in Computational Decision Sciences and Operations Research (with Applied Mathematics) (p. 276)

Dual Degree Program

- Master of Science in Computer Science/Master of Chemical Engineering (with Chemical and Biological Engineering) (p. 279)

Certificates

- Computational Intelligence (p. 286)
- Cyber-Physical Systems (p. 286)
- Data Analytics (p. 286)
- Database Systems (p. 287)
- Distributed and Cloud Computing (p. 287)
- Information Security and Assurance (p. 288)
- Networking and Communications (p. 288)
- Software Engineering (p. 288)

Mathematics and Science Education

- Master of Mathematics Education (p. 295)
- Master of Mathematics Education (Teacher Certification Option) (p. 295)
- Master of Science Education (p. 296)
- Master of Science Education (Teacher Certification Option) (p. 296)
- Master of Science in Mathematics Education (p. 297)
- Master of Science in Mathematics Education with STEM Leadership Cohort (p. 297)
- Master of Science in Science Education (p. 298)
- Master of Science in Science Education with STEM Leadership Cohort (p. 298)
- Doctor of Philosophy in Collegiate Mathematics Education (p. 299)
- Doctor of Philosophy in Mathematics Education (p. 301)
- Doctor of Philosophy in Science Education (p. 302)

Physics

- Master of Health Physics (p. 309)
- Master of Science in Applied Physics (p. 310)
- Master of Science in Physics (p. 311)
- Doctor of Philosophy in Physics (p. 312)

Certificates

- Radiological Physics (p. 313)

Applied Mathematics

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science.iit.edu/applied-mathematics

Chair
Fred J. Hickernell

Director, Graduate Studies
Xiaofan Li

Faculty with Research Interests
For more information regarding faculty visit the Department of Applied Mathematics website.

The Department of Applied Mathematics puts mathematics to work solving problems in science, engineering, and society. Applied mathematicians investigate a wide variety of topics, such as how to construct methods for multi-criteria decision making (requiring discrete mathematics and statistics), predicting how financial markets will behave (requiring probability/statistics, analysis, and optimization), and understanding how liquids flow around solids (requiring computational methods and analysis).

Our programs focus on four areas of modern applied mathematics: applied analysis, computational mathematics, discrete applied mathematics, and stochastics. More detailed descriptions of these areas follow.

Research Facilities

The department provides students with office space equipped with computers and full access to the university's computer and library resources. The department also has a 128-core computer cluster for research purposes.

Research and Program Areas

The research and teaching foci of the Department of Applied Mathematics are primarily in four areas of modern applied mathematics: applied analysis, computational mathematics, discrete applied mathematics, and stochastics. These areas are briefly described in the following subsections, which also include the faculty with primary and secondary interests in that area.

Applied Analysis

Applied analysis is one of the foundations for interdisciplinary applied mathematics. The principles of (functional) analysis are applied to such areas as partial differential equations, dynamical systems, and numerical analysis.

The basic framework, concepts, and techniques of modern mathematical analysis are essential for modeling, analysis, and simulation of complicated phenomena in engineering and science. Applying the ideas and methods of modern mathematical analysis to such problems has been a thoroughly interdisciplinary effort.

Research and teaching within the applied analysis group at the university concentrates on development and application of new techniques for investigating numerous phenomena in engineering and science. In particular, members of the group do research in nonlinear dynamics, approximation theory, numerical analysis, fluid dynamics, materials science, viscoelastic and polymeric fluid flows, biological science, quantum mechanics and electro-dynamics, solid mechanics, financial engineering, and other disciplines.

Primary interests: Bielecki, Duan, Lubin
Secondary interests: Cialenco, Fasshauer, S. Li, X. Li, Nair, Rempfer, Tier

Computational Mathematics

The use of computation/simulation as a third alternative to theory and experimentation is now common practice in many branches of science and engineering. Many scientific problems that were previously inaccessible have seen tremendous progress from the use of computation (e.g., many-body simulations in physics and chemistry, simulation of semi-conductors, etc.). Researchers and scientists in these areas must have a sound training in the fundamentals of computational mathematics and become proficient in the use (and development) of new algorithms and analytical techniques as they apply to modern computational environments.

Research and teaching within the computational mathematics group at the university concentrates on basic numerical analysis, as well as development of new computational methods used in the study and solution of problems in the applied sciences and engineering. In particular, members of the group do research on complexity theory, the finite element method, meshfree methods, multiscale and multilevel methods, Monte Carlo and quasi-Monte Carlo methods, numerical methods for deterministic and stochastic ordinary and partial differential equations, computational fluid dynamics, computational materials science, computer-aided geometric design, and parallel computation.

Primary interests: Fasshauer, Hickernell, S. Li, X. Li, Tier
Secondary interests: Duan, Petrovic, Rempfer

Discrete Applied Mathematics

Discrete applied mathematics is a fairly young branch of mathematics and is concerned with using combinatorics, graph theory, optimization, and portions of theoretical computer science to attack problems in engineering, as well as the hard and soft sciences.

Research interests in the discrete applied mathematics group at the university are in discrete methods in computational and mathematical biology, intersection graphs and their applications, discrete location theory, voting theory applied to data analysis, graph drawing, random geometric graphs, communication networks, coding theory, low discrepancy sequences, algorithm design, and analysis.

Primary interests: Ellis, Kaul, Pelsmajer, Reingold
Secondary interests: Hickernell, Kang, Petrovic, Weening

Stochastics

Stochastics at the university includes traditional statistics (the methods of data analysis and inference) and probability (the modeling of uncertainty and randomness). However, also included are other areas where stochastic methods have been becoming more important in recent years such as finite and infinite dimensional stochastic processes, stochastic integration, stochastic dynamics, stochastic partial differential equations, probabilistic methods for analysis, mathematical finance and discrete mathematics, computational methods for stochastic systems, etc.

The current research and teaching interests in the stochastic analysis group at the university include asymptotics in statistics, experimental design, computational statistics, stochastic calculus and probability theory, stochastic dynamical systems, stochastic control, stochastic partial differential equations, and statistical decision theory.

Primary interests: Adler, Bielecki, Cialenco, Duan, Hickernell, Kang, Petrovic, Tier
Secondary interests: Ellis, Kaul

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0

GRE score minimum

M.A.S. and M.S.

304 (quantitative + verbal); 2.5 (analytical writing)
Before 2011: 1100 (quantitative + verbal)

Ph.D.

304 (quantitative + verbal); 3.0 (analytical writing)
Before 2011: 1100 (quantitative + verbal)

TOEFL minimum

80/213/550 (internet/computer/paper-based test scores)
At least two letters of recommendation

Admission to the professional master's program in mathematical finance requires a bachelor's degree in mathematics, engineering, or the equivalent, with a minimum cumulative GPA of 3.0/4.0. TOEFL scores (if required) must have a minimum score of 100/250 (internet/computer-based test score). A professional statement of goals/objectives (2 pages) and a curriculum vitae must be submitted. Three letters of recommendation are required (at least two must be from academia, the third may be from industry). An interview may also be required.

Typically, admitted students score at least 156 on the quantitative portion of the GRE and at least 3.0 on the analytical writing portion. However, meeting the minimum or typical GPA test score requirements does not guarantee admission. GPA and test scores are just two of several important factors considered for admission to the program, including grades in mathematics courses, letters of recommendation, and the student's overall record of achievements.

Admission to the master of science and the Ph.D. program normally requires a bachelor's degree in mathematics or applied mathematics. Candidates whose degree is in another field (for example, computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply. Candidates in the Ph.D. program must also have demonstrated the potential for conducting original research in applied mathematics. Students must remove deficiencies in essential undergraduate courses that are prerequisites for the degree program, in addition to fulfilling all other degree requirements.

The director of graduate studies serves as temporary academic adviser for newly admitted graduate students in the master of science and the Ph.D. programs until an appropriate faculty member is selected as the adviser. Students are responsible for following all departmental procedures, as well as the general requirements of the Graduate College.

Degrees Offered

- Master of Applied Mathematics (p. 218)
- Master of Science in Applied Mathematics (p. 222)
- Doctor of Philosophy in Applied Mathematics (p. 225)

Joint Degree Programs

- Master of Data Science (with Computer Science) (p. 219)
- Master of Mathematical Finance (with Business) (p. 221)
- Master of Science in Computational Decision Sciences and Operations Research (with Computer Science) (p. 223)

Course Descriptions

MATH 500
Applied Analysis I
Measure Theory and Lebesgue Integration; Metric Spaces and Contraction Mapping Theorem, Normed Spaces; Banach Spaces; Hilbert Spaces.
Prerequisite(s): [(MATH 400)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 501
Applied Analysis II
Bounded Linear Operators on a Hilbert Space; Spectrum of Bounded Linear Operators; Fourier Series; Linear Differential Operators and Green's Functions; Distributions and the Fourier Transform; Differential Calculus and Variational Methods.
Prerequisite(s): [(MATH 500)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 512
Partial Differential Equations
Basic model equations describing wave propagation, diffusion and potential functions; characteristics, Fourier transform, Green function, and eigenfunction expansions; elementary theory of partial differential equations; Sobolev spaces; linear elliptic equations; energy methods; semigroup methods; applications to partial differential equations from engineering and science.
Prerequisite(s): [(MATH 461) OR (MATH 489)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 515
Ordinary Differential Equations and Dynamical Systems
Basic theory of systems of ordinary differential equations; equilibrium solutions, linearization and stability; phase portraits analysis; stable unstable and center manifolds; periodic orbits, homoclinic and heteroclinic orbits; bifurcations and chaos; nonautonomous dynamics; and numerical simulation of nonlinear dynamics.
Prerequisite(s): [(MATH 252)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 519
Complex Anyalysis
Analytic functions, contour integration, singularities, series, conformal mapping, analytic continuation, multivalued functions.
Prerequisite(s): [(MATH 402)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 522
Mathematical Modeling
The course provides a systematic approach to modeling applications from areas such as physics and chemistry, engineering, biology, and business (operations research). The mathematical models lead to discrete or continuous processes that may be deterministic or stochastic. Dimensional analysis and scaling are introduced to prepare a model for study. Analytic and computational tools from a broad range of applied mathematics will be used to obtain information about the models. The mathematical results will be compared to physical data to assess the usefulness of the models. Credit may not be granted for both MATH 486 and MATH 522.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 523
Case Studies and Project Design in Applied Mathematics
The goal of the course is for students to learn how to use applied mathematics methods and skills to analyze real-world problems and to communicate their results in a non-academic setting. Students will work in groups of 2 or 3 to study and analyze problems and then provide useful information to a potential client. The time distribution is flexible and includes discussions of problems, presentation of needed background material and the required reports, and presentations by the teams. Several small projects will be examined and reported on.
Prerequisite(s): [(CHEM 511 and MATH 522)]
Lecture: 6 **Lab:** 0 **Credits:** 6

MATH 525
Statistical Models and Methods
Concepts and methods of gathering, describing and analyzing data including statistical reasoning, basic probability, sampling, hypothesis testing, confidence intervals, correlation, regression, forecasting, and nonparametric statistics. No knowledge of calculus is assumed. this course is useful for graduate students in education or the social sciences. This course does not count for graduation in any mathematics program. Credit given only for one of the following: MATH 425, MATH 476, or MATH 525.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 530
Applied and Computational Algebra
Basics of computation with systems of polynomial equations, ideals in polynomial rings; solving systems of equations by Groebner bases; introduction to elimination theory; algebraic varieties in affine n-space; Zariski topology; dimension, degree, their computation and theoretical consequences.
Prerequisite(s): [(MATH 332) OR (MATH 532)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 532
Linear Algebra
Matrix algebra, vector spaces, norms, inner products and orthogonality, determinants, linear transformations, eigenvalues and eigenvectors, Cayley-Hamilton theorem, matrix factorizations (LU, QR, SVD).
Prerequisite(s): [(MATH 332)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 535
Optimization I
Introduction to both theoretical and algorithmic aspects of linear optimization: geometry of linear programs, simplex method, anticycling, duality theory and dual simplex method, sensitivity analysis, large scale optimization via Dantzig-Wolfe decomposition and Benders decomposition, interior point methods, network flow problems, integer programming. Credit may not be given for both MATH 435 and MATH 535.
Prerequisite(s): [(MATH 332)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 540
Probability
Random events and variables, probability distributions, sequences of random variables, limit theorems, conditional expectations, and martingales.
Prerequisite(s): [(MATH 400)]AND[(MATH 475)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 542
Stochastic Processes
This is an introductory course in stochastic processes. Its purpose is to introduce students into a range of stochastic processes, which are used as modeling tools in diverse field of applications, especially in the business applications. The course introduces the most fundamental ideas in the area of modeling and analysis of real World phenomena in terms of stochastic processes. The course covers different classes of Markov processes: discrete and continuous-time Markov chains, Brownian motion, and diffusion processes. It also presents some aspects of stochastic calculus with emphasis on the application to financial modeling and financial engineering.
Prerequisite(s): [(MATH 332) OR (MATH 333)]AND[(MATH 475)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 543
Stochastic Analysis
This course will introduce the student to modern finite dimensional stochastic analysis and its applications. The topics will include: a) an overview of modern theory of stochastic processes, with focus on semimartingales and their characteristics, b) stochastic calculus for semimartingales, including Ito formula and stochastic integration with respect to semimartingales, c) stochastic differential equations (SDE's) driven by semimartingales, with focus on stochastic SDE's driven by Levy processes, d) absolutely continuous changes of measures for semimartingales, e) some selected applications.
Prerequisite(s): [(MATH 540)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 544
Stochastic Dynamics
This course is about modeling, analysis, simulation and prediction of dynamical behavior of complex systems under random influences. The mathematical models for such systems are in the form of stochastic differential equations. It is especially appropriate for graduate students who would like to use stochastic methods in their research, or to learn these methods for long term career development. Topics include white noise and colored noise, stochastic differential equations, random dynamical systems, numerical simulation, and applications to scientific, engineering and other areas.
Prerequisite(s): [(MATH 540)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 545
Stochastic Partial Differential Equations
This course introduces various methods for understanding solutions and dynamical behaviors of stochastic partial differential equations arising from mathematical modeling in science, engineering, and other areas. It is designed for graduate students who would like to use stochastic methods in their research or to learn such methods for long term career development. Topics include the following: Random variables; Brownian motion and stochastic calculus in Hilbert spaces; Stochastic heat equation; Stochastic wave equation; Analytical and approximation techniques; Stochastic numerical simulations via Matlab; and applications to science, engineering, and other areas.
Prerequisite(s): [(MATH 540) OR (MATH 543) OR (MATH 544)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 546
Introduction to Time Series
Properties of stationary, random processes; standard discrete parameter models, autoregressive, moving average, harmonic; standard continuous parameter models. Spectral analysis of stationary processes, relationship between the spectral density function and the autocorrelation function; spectral representation of some stationary processes; linear transformations and filters. Introduction to estimation in the time and frequency domains.
Prerequisite(s): [(ECE 511) OR (MATH 475)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 548
Mathematical Finance I
This is an introductory course in mathematical finance. Technical difficulty of the subject is kept at a minimum by considering a discrete time framework. Nevertheless, the major ideas and concepts underlying modern mathematical finance and financial engineering are explained and illustrated.
Prerequisite(s): [(MATH 474) OR (MATH 475)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 550
Topology
Topological spaces, continuous mappings and homeomorphisms, metric spaces and metrizability, connectedness and compactness, homotopy theory.
Prerequisite(s): [(MATH 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 553
Discrete Applied Mathematics I
A graduate-level introduction to modern graph theory through existential and algorithmic problems, and the corresponding structural and extremal results from matchings, connectivity, planarity, coloring, Turan-type problems, and Ramsey theory. Proof techniques based on induction, extremal choices, and probabilistic methods will be emphasized with a view towards building an expertise in working in discrete applied mathematics.
Prerequisite(s): [(MATH 454)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 554
Discrete Applied Mathematics II
A graduate-level course that introduces students in applied mathematics, computer science, natural sciences, and engineering, to the application of modern tools and techniques from various fields of mathematics to existential and algorithmic problems arising in discrete applied math. Probabilistic methods, entropy, linear algebra methods, Combinatorial Nullstellensatz, and Markov chain Monte Carlo, are applied to fundamental problems like Ramsey-type problems, intersecting families of sets, extremal problems on graphs and hypergraphs, optimization on discrete structures, sampling and counting discrete objects, etc.
Prerequisite(s): [(MATH 454) OR (MATH 553)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 555
Tensor Analysis
Development of the calculus of tensors with applications to differential geometry and the formulation of the fundamental equations in various fields.
Prerequisite(s): [(MATH 332 and MATH 400)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 556
Metric Spaces
Point-set theory, compactness, completeness, connectedness, total boundedness, density, category, uniform continuity and convergence, Stone-Weierstrass theorem, fixed point theorems.
Prerequisite(s): [(MATH 400)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 557
Probabilistic Methods in Combinatorics
Graduate level introduction to probabilistic methods, including linearity of expectation, the deletion method, the second moment method and the Lovasz Local Lemma. Many examples from classical results and recent research in combinatorics will be included throughout, including from Ramsey Theory, random graphs, coding theory and number theory.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 563
Mathematical Statistics
Theory of sampling distributions; principles of data reduction; interval and point estimation, sufficient statistics, order statistics, hypothesis testing, correlation and linear regression; introduction to linear models. Credit given only for one of MATH 425, MATH 476, MATH 525, or MATH 563.
Prerequisite(s): [(MATH 475)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 564
Applied Statistics
Simple linear regression; multiple linear regression; least squares estimates of parameters; hypothesis testing and confidence intervals in linear regression models; testing of models, data analysis, and appropriateness of models; linear time series models; moving average, autoregressive and/or ARIMA models; estimation, data analysis, and forecasting with time series models; forecasting errors and confidence intervals. Credit may not be granted for both MATH 484 and MATH 564.
Prerequisite(s): [(MATH 474) OR (MATH 476) OR (MATH 563)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 565
Monte Carlo Methods in Finance
In addition to the theoretical constructs in financial mathematics, there are also a range of computational/simulation techniques that allow for the numerical evaluation of a wide range of financial securities. This course will introduce the student to some such simulation techniques, known as Monte Carlo methods, with focus on applications in financial risk management. Monte Carlo and Quasi Monte Carlo techniques are computational sampling methods which track the behavior of the underlying securities in an option or portfolio and determine the derivative's value by taking the expected value of the discounted payoffs at maturity. Recent developments with parallel programming techniques and computer clusters have made these methods widespread in the finance industry.
Prerequisite(s): [(MATH 474)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 566
Multivariate Analysis
Random vectors, sample geometry and random sampling, generalized variance, multivariate normal and Wishart distributions, estimation of mean vector, confidence region, Hotelling's T-square, covariance, principal components, factor analysis, discrimination, clustering.
Prerequisite(s): [(MATH 532, MATH 563, and MATH 564)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 567
Advanced Design of Experiments
Various type of designs for laboratory and computer experiments, including fractional factorial designs, optimal designs and space filling designs.
Prerequisite(s): [(MATH 474) OR (MATH 476)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 568
Topics in Statistics
Categorical data analysis, contingency tables, log-linear models, nonparametric methods, sampling techniques.
Prerequisite(s): [(MATH 563)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 569
Statistical Learning
The wealth of observational and experimental data available provides great opportunities for us to learn more about our world. This course teaches modern statistical methods for learning from data, such as regression, classification, kernel methods, and support vector machines.
Prerequisite(s): [(MATH 350)]AND[(MATH 474) OR (MATH 475)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 570
Data Science Seminar
Various research topics on data science are presented in this seminar. Permission is required from the instructor or department.
Lecture: 0 **Lab:** 0 **Credits:** 0

MATH 571
Data Preparation and Analysis
This course surveys industrial and scientific applications of data analytics with case studies including exploration of ethical issues. Students will learn how to prepare data for analysis, perform exploratory data analysis, and develop meaningful data visualizations. They will work with a variety of real world data sets and learn how to prepare data sets for analysis by cleaning and reformatting. Students will also learn to apply a variety of different data exploration techniques including summary statistics and visualization methods.
Prerequisite(s): [(CSP 570*) OR (MATH 570*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 572
Data Science Practicum
In this project-oriented course, students will work in small groups to solve real-world data analysis problems and communicate their results. Innovation and clarity of presentation will be key elements of evaluation. Students will have an option to do this as an independent data analytics internship with an industry partner.
Prerequisite(s): [(CSP 571) OR (MATH 571)]AND[(SCI 522)]
Lecture: 3 **Lab:** 3 **Credits:** 6

MATH 573
Reliable Mathematical Software
Many mathematical problems cannot be solved analytically or by hand in a reasonable amount of time; so, turn to mathematical software to solve these problems. Popular examples of general-purpose mathematical software include Mathematica, MATLAB, the NAG Library, and R. Researchers often find themselves writing mathematical software to demonstrate their new ideas or using mathematical software written by others to solve their applications. This course covers the ingredients that go into producing mathematical software that is efficient, robust, and trustworthy. Students will write their own packages or parts of packages to practice the principles of reliable mathematical software.
Lecture: 1 **Lab:** 0 **Credits:** 0

MATH 574
Bayesian Computational Statistics
Rigorous introduction to the theory of Bayesian statistical inference and data analysis including prior and posterior distributions, Bayesian estimation and testing, Bayesian computation theories and methods, and implementation of Bayesian computation methods using popular statistical software.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 577
Computational Mathematics I
Fundamentals of matrix theory; least squares problems; computer arithmetic, conditioning and stability; direct and iterative methods for linear systems; eigenvalue problems. Credit may not be granted for both Math 577 and Math 477. Prerequisite: An undergraduate numerical course, such as MATH 350 or instructor permission.
Prerequisite(s): [(MATH 350)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 578
Computational Mathematics II
Polynomial interpolation; numerical solution of initial value problems for ordinary differential equations by single and multi-step methods, Runge-Kutta, Predictor-Corrector; numerical solution of boundary value problems for ordinary differential equations by shooting method, finite differences and spectral methods. Credit may not be granted for both MATH 578 and MATH 478. Prerequisite: An undergraduate numerical course, such as MATH350 or instructor's consent.
Prerequisite(s): [(MATH 350)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 579
Complexity of Numerical Problems
This course is concerned with a branch of complexity theory. It studies the intrinsic complexity of numerical problems, that is, the minimum effort required for the approximate solution of a given problem up to a given error. Based on a precise theoretical foundation, lower bounds are established, i.e. bounds that hold for all algorithms. We also study the optimality of known algorithms, and describe ways to develop new algorithms if the known ones are not optimal.
Prerequisite(s): [(MATH 350)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 581
Finite Element Method
Various elements, error estimates, discontinuous Galerkin methods, methods for solving system of linear equations including multigrid. Applications.
Prerequisite(s): [(MATH 400)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 582
Mathematical Finance II
This course is a continuation of Math 485/548. It introduces the student to modern continuous time mathematical finance. The major objective of the course is to present main mathematical methodologies and models underlying the area of financial engineering, and, in particular, those that provide a formal analytical basis for valuation and hedging of financial securities.
Prerequisite(s): [(MATH 481) OR (MATH 542)]AND[(MATH 485) OR (MATH 548)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 586
Theory and Practice of Fixed Income Modeling
The course covers basics of the modern interest rate modeling and fixed income asset pricing. The main goal is to develop a practical understanding of the core methods and approaches used in practice to model interest rates and to price and hedge interest rate contingent securities. The emphasis of the course is practical rather than purely theoretical. A fundamental objective of the course is to enable the students to gain a hand-on familiarity with and understanding of the modern approaches used in practice to model interest rate markets.
Prerequisite(s): [(MATH 485 and MATH 582*) OR (MATH 543 and MATH 582*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 587
Theory and Practice of Modeling Risk and Credit Derivatives
This is an advanced course in the theory and practice of credit risk and credit derivatives. Students will get acquainted with structural and reduced form approaches to mathematical modeling of credit risk. Various aspects of valuation and hedging of defaultable claims will be presented. In addition, valuation and hedging of vanilla credit derivatives, such as credit default swaps, as well as vanilla credit basket derivatives, such as collateralized credit obligations, will be discussed.
Prerequisite(s): [(MATH 582)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 589
Numerical Methods for Partial Differential Equations
This course introduces numerical methods, especially the finite difference method for solving different types of partial differential equations. The main numerical issues such as convergence and stability will be discussed. It also includes introduction to the finite volume method, finite element method and spectral method. Prerequisite: An undergraduate numerical course such as MATH 350 and MATH 489 or consent of instructor.
Prerequisite(s): [(MATH 350 and MATH 489)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 590
Meshfree Methods
Fundamentals of multivariate meshfree radial basis function and moving least squares methods; applications to multivariate interpolation and least squares approximation problems; applications to the numerical solution of partial differential equations; implementation in Matlab.
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 591
Research and Thesis M.S.
Prerequisite: Instructor permission required.
Credit: Variable

MATH 592
Internship in Applied Mathematics
The course is for students in the Master of Applied Mathematics program who have an approved summer internship at an outside organization. This course can be used in place of Math 523 subject to the approval of the director of the program.
Lecture: 0 **Lab:** 0 **Credits:** 6

MATH 593
Seminar in Applied Mathematics
Current research topics presented in the department colloquia and seminars.
Lecture: 1 **Lab:** 0 **Credits:** 0

MATH 594
Professional Master's Project
The course is part of the capstone experience for students in the Master of Applied Mathematics program. Students will work in groups of 2 or 3 to study and analyze a real-world problem.
Credit: Variable

MATH 597
Reading and Special Projects
(Credit: Variable)
Credit: Variable

MATH 599
TA Training
This course provides the foundation of how to teach mathematics in the context of introductory undergraduate courses. The course is designed to encourage participation and cooperation among the graduate students, to help them prepare for a career in academia, and to help convey the many components of effective teaching.
Lecture: 1 **Lab:** 0 **Credits:** 0

MATH 601
Advanced Topics in Combinatorics
Course content is variable and reflects current research in combinatorics.
Prerequisite(s): [(MATH 554)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 602
Advanced Topics in Graph Theory
Course content is variable and reflects current research in graph theory.
Prerequisite(s): [(MATH 554)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 603
Advanced Topics in Computational Mathematics
Course content is variable and reflects current research in computational mathematics.
Prerequisite(s): [(MATH 578)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 604
Advanced Topics in Applied Analysis
Course content is variable and reflects current research in applied analysis.
Prerequisite(s): [(MATH 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 605
Advanced Topics in Stochastics
Course content is variable and reflects current research in stochastic.
Prerequisite(s): [(MATH 544)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MATH 691
Research and Thesis Ph.D.
(Credit: Variable)
Credit: Variable

SCI 511
Project Management
Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 522
Public Engagement for Scientists
This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

Master of Applied Mathematics

The Master of Applied Mathematics program at Illinois Institute of Technology is a non-thesis professional master's degree program that provides graduates with mathematics training for technology-based jobs in business, industry, or government. Graduates develop state-of-the-art skills in modeling, analysis, and computation needed to solve real-world problems. The program requires students to learn writing and communication skills along with teamwork and project management skills. The program can typically be completed in 15 months, with three regular term semesters and one summer semester.

Curriculum

Applied Mathematics and Computational Science Core			(9)
MATH 475	Probability		3
or MATH 563	Mathematical Statistics		
MATH 522	Mathematical Modeling		3
MATH 577	Computational Mathematics I		3
Business and Professional Core			(6)
SCI 511	Project Management		3
SCI 522	Public Engagement for Scientists		3
Capstone Professional Experience			(9)
MATH 523	Case Studies and Project Design in Applied Mathematics		6
or MATH 592	Internship in Applied Mathematics		
MATH 594	Professional Master's Project		3
Elective Courses			(6)
Select a minimum of two courses from the following:			6
Advanced Computation			
MATH 489	Partial Differential Equations	3	
MATH 565	Monte Carlo Methods in Finance	3	
MATH 578	Computational Mathematics II	3	
MATH 581	Finite Element Method	3	
MATH 589	Numerical Methods for Partial Differential Equations	3	
CS 595	Topics in Computer Science	3-12	
MSF 526	Computational Finance	3	
Stochastic Modeling and Analysis			
MATH 481	Introduction to Stochastic Processes	3	
MATH 485	Introduction to Mathematical Finance	3	
MATH 542	Stochastic Processes	3	
MATH 548	Mathematical Finance I	3	
MATH 582	Mathematical Finance II	3	
Statistical and Data Analytics			
MATH 563	Mathematical Statistics	3	
MATH 564	Applied Statistics	3	
MATH 565	Monte Carlo Methods in Finance	3	
MATH 567	Advanced Design of Experiments	3	
Discrete Mathematics and Optimization			
MATH 535	Optimization I	3	
MATH 553	Discrete Applied Mathematics I	3	
MATH 554	Discrete Applied Mathematics II	3	
Total Credit Hours			30

Degree Requirements

All Graduate College requirements must be satisfied. Specific departmental requirements follow.

Credit Requirements

The student must complete 30 credit hours and maintain a 3.0/4.0 GPA. There are 24 credit hours of required, core courses. Six credit hours of electives, selected in consultation with, and approval of, the program director are required. The program may include a maximum of 9 credit hours at the 400-level.

Capstone Professional Experience

The capstone consists of a 6 credit hour course in case studies and project management or an internship in applied mathematics.

Master's Project

The project, which is 3 credit hours of MATH 594, is conducted under the supervision of a faculty member or an industrial partner.

Course Substitutions and Prerequisites

Course substitutions and needed prerequisite courses may be permitted, subject to the approval of the program director.

Master of Data Science

Collaborative program with the Department of Computer Science

This professional master’s degree program consists of 33 credit hours of coursework, including a practicum, in data science. The program is designed primarily for those with previous degrees or experience in computer science, statistics, mathematics, natural sciences, or business, who are interested in preparing for a career as a data science professional in business and industry. Full-time students may complete the program in one year, including one summer term.

Admission Requirements

Applicants should have a bachelor’s degree from an accredited university with a minimum cumulative GPA of 3.0/4.0. A combined verbal and quantitative GRE examination score of at least 304 and an analytic writing score of at least 3.0 (for the post-October 2002 test) are required. The GRE requirement is waived for students with a bachelor’s degree from an accredited college or university in the United States with a cumulative GPA of at least 3.0/4.0.

Prerequisites include knowledge of a high level programming language at the level of CS 201 (Java or C/C++programming is required), a data structures course at the level of CS 331, experience with database programming at the level of CS 425, linear algebra at the level of MATH 332, and probability and statistics at the level of MATH 474. Information on these courses is available in this catalog.

Students with an insufficient background in computer science and/or mathematics will be required to take the relevant prerequisite courses and earn at least a B grade in each. These prerequisite courses do not count toward the 33 credit hour requirement.

Curriculum

Coursework includes 18 credit hours of required core courses and 6 credit hours of CSP 572/MATH 572 Data Science Practicum. At least 9 credit hours must be taken of 500-level CS or CSP courses and 9 credit hours of 500-level MATH courses, not including the CSP 572/MATH 572 Data Science Practicum.

Up to 6 credit hours of 400-level undergraduate coursework may be used toward degree requirements.

Code	Title	Credit Hours
Data Science Core Courses		(18)
CS 525	Advanced Database Organization	3
or CS 554	Data-Intensive Computing	
MATH 563	Mathematical Statistics	3
or MATH 564	Applied Statistics	
SCI 511	Project Management	3
SCI 522	Public Engagement for Scientists	3
CS 584	Machine Learning	3
or MATH 569	Statistical Learning	
CSP 571	Data Preparation and Analysis	3
or MATH 571	Data Preparation and Analysis	
Data Science Capstone		(6)

CSP/MATH 572	Data Science Practicum	6
Data Science Electives		(9)
Select 9 credit hours of Data Science Electives		9
Total Credit Hours		33

Data Science Electives

Code	Title	Credit Hours
Computational Fundamentals		(27)
CS 425	Database Organization	3
CS 430	Introduction to Algorithms	3
CS 450	Operating Systems	3
CS 525	Advanced Database Organization	3
CS 535	Design and Analysis of Algorithms	3
CS 546	Parallel and Distributed Processing	3
CS 553	Cloud Computing	3
CS 554	Data-Intensive Computing	3
CS 589	Software Testing and Analysis	3
Computer Science Applications		(33)
CS 422	Data Mining	3
CS 512	Computer Vision	3
CS 513	Geospatial Vision and Visualization	3
CS 522	Advanced Data Mining	3
CS 529	Information Retrieval	3
CS 556	Cyber-Physical Systems: Languages and Systems	3
CS 557	Cyber-Physical Systems: Networking and Algorithms	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 584	Machine Learning	3
CS 585	Natural Language Processing	3
Mathematics, Probability, and Statistics		(33)
MATH 454	Graph Theory and Applications	3
MATH 486	Mathematical Modeling I	3
MATH 532	Linear Algebra	3
MATH 540	Probability	3
MATH 542	Stochastic Processes	3
MATH 553	Discrete Applied Mathematics I	3
MATH 554	Discrete Applied Mathematics II	3
MATH 565	Monte Carlo Methods in Finance	3
MATH 567	Advanced Design of Experiments	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Statistics	3
Mathematical and Scientific Computing		(15)
BIOL 550	Bioinformatics	3
MATH 577	Computational Mathematics I	3
MATH 578	Computational Mathematics II	3
MATH 590	Meshfree Methods	3
PHYS 440	Computational Physics	3

Master of Mathematical Finance

Collaborative program with the Stuart School of Business

The objective of the Master of Mathematical Finance program is to provide individuals interested in pursuing careers in financial risk management with advanced education in theoretical, computational, and business aspects of relevant quantitative methodologies. This is a collaborative program between the Stuart School of Business and the Department of Applied Mathematics, and as such, it gives students the chance to benefit from the strength of both units. Students are required to complete a total of eleven semester courses, including eight core courses and three elective courses.

Curriculum

Code	Title		Credit Hours
Core Courses			(24)
MSF 505	Futures, Options, and OTC Derivatives		3
MSF 526	Computational Finance		3
MSF 575	C++ with Financial Markets		3
MATH 542	Stochastic Processes		3
MATH 548	Mathematical Finance I		3
MATH 565	Monte Carlo Methods in Finance		3
MATH 582	Mathematical Finance II		3
MATH 586	Theory and Practice of Fixed Income Modeling		3
Applied Mathematics Elective Courses			(3)
Select a minimum of one course from the following:			3
CS 522	Advanced Data Mining	3	
MATH 512	Partial Differential Equations	3	
MATH 522	Mathematical Modeling	3	
MATH 540	Probability	3	
MATH 543	Stochastic Analysis	3	
MATH 544	Stochastic Dynamics	3	
MATH 545	Stochastic Partial Differential Equations	3	
MATH 546	Introduction to Time Series	3	
MATH 566	Multivariate Analysis	3	
MATH 567	Advanced Design of Experiments	3	
MATH 569	Statistical Learning	3	
MATH 577	Computational Mathematics I	3	
MATH 578	Computational Mathematics II	3	
MATH 579	Complexity of Numerical Problems	3	
MATH 587	Theory and Practice of Modeling Risk and Credit Derivatives	3	
MATH 589	Numerical Methods for Partial Differential Equations	3	
MATH 590	Meshfree Methods	3	
Finance Elective Courses			(3)
Select a minimum of one course from the following:			3
MSF 524	Models for Derivatives	3	
MSF 525	Term Structure Modeling and Interest Rate Derivatives	3	
MSF 545	Structured Fixed Income Portfolios	3	
MSF 546	Quantitative Investment Strategies	3	
MSF 554	Market Risk Management	3	
MSF 555	Credit Risk Management	3	
MSF 566	Time Series Analysis	3	
MSF 567	Bayesian Econometrics	3	
MSF 574	.NET and Database Management	3	
MSF 576	OOP and Algorithmic Trading Systems	3	
MSF 577	High Frequency Finance	3	

MSF 584	Equity and Equity Derivatives Trading	3
MSF 585	Foreign Exchange Market and Fixed Income Strategies	3
Additional Elective Course		(3)
Select one course [1]		3
Total Credit Hours		33

[1] One graduate level elective may be taken from outside the prescribed mathematical finance courses described above, provided that it is consistent with the Master of Mathematical Finance program objectives and has been approved by the program director prior to the student's registration.

Core Requirement

All mathematical finance students must complete the eight core classes unless they have obtained written permission from their academic adviser to substitute an alternative class for a core class.

Course Substitutions

To the extent that students have completed commensurate coursework or professional experience, substitutions to the required curriculum may be permitted, with the approval of the academic adviser.

Transfer Credit

Students may also transfer up to two classes from a graduate program at another accredited university if the student has not used the classes to satisfy the requirements for a degree at the previous university. Additional classes may be transferred with the permission of the program director.

Prerequisite Courses

Some students may be required to take prerequisite courses in mathematics, statistics, or computer programming before being admitted to a graduate course.

Master of Science in Applied Mathematics

Thesis option

The Master of Science in Applied Mathematics degree program provides a broad background in the fundamentals of the advanced mathematics that is applied to solve problems in other fields. The goal is to prepare students for careers in industry and for the doctoral program, and students may pursue an optional thesis.

Curriculum

Core Courses			(9)
A minimum grade point average of 3.0/4.0 is required in the core courses.			
MATH 500	Applied Analysis I		3
MATH 577	Computational Mathematics I		3
Select a minimum of one course from the following:			3
MATH 540	Probability	3	
MATH 553	Discrete Applied Mathematics I	3	
MATH 563	Mathematical Statistics	3	
Additional Requirements			(0)
MATH 593	Seminar in Applied Mathematics [1]		0
Elective Courses			(15-23)
Select 15-23 credit hours [2]			15-23
Thesis Research			(0-8)
MATH 591	Research and Thesis M.S. [3]		0-8

Minimum degree credits required: 32

[1] Students must take the colloquium/seminar course MATH 593 at least twice with a satisfactory grade.

[2] The remaining courses in each student's program are selected in consultation with, and approval of, the director of graduate studies. The program may include at most three courses at the 400-level and at most two courses outside the department.

[3] Research students pursuing the thesis option must complete 5 to 8 credit hours of MATH 591.

Comprehensive Examination

The comprehensive examination requirement is fulfilled by a master's thesis (5-8 credit hours of MATH 591) under the supervision of a faculty member, or by passing written tests in two of the five core areas of study at the master of science level.

Master of Science in Computational Decision Sciences and Operations Research

Collaborative program with the Department of Computer Science

The purpose of this program is to provide students with theoretical skills and knowledge of applications in the areas of optimization, game theory, and machine learning to enable them to contribute towards making business decisions more efficient, or alternatively, to enable them to pursue research in these areas.

Admission Requirements

Students with bachelor of science degrees in mathematics, computer science, industrial engineering, electrical and computer engineering, mechanical engineering, and business, or related areas, with a minimum cumulative GPA of at least 3.0/4.0, will be considered. Prospective students should have knowledge of linear algebra, discrete mathematics, probability and statistics, and programming.

All applications will be considered on an individual basis and strong applicants without an adequate background might be admitted with a requirement to take additional prerequisite courses. A statement of objectives and a curriculum vitae must be submitted. Two letters of recommendation are required. GRE scores must meet Illinois Institute of Technology institutional requirements.

Curriculum

Coursework includes 12 credit hours of required core courses and 20 credit hours of elective courses. Up to 12 credit hours of 400-level coursework may be included in the program with adviser approval. A student may, with permission of a thesis adviser, include in his or her program a thesis of up to 5 credit hours consisting of a combination of CS 591 and/or MATH 591. The thesis option requires a written thesis and an oral defense of the thesis. Thesis format and deadlines are set by the Graduate College.

Code	Title		Credit Hours
Core Courses			(12)
CS 430	Introduction to Algorithms		3
or CS 535	Design and Analysis of Algorithms		
MATH 481	Introduction to Stochastic Processes		3
or MATH 564	Applied Statistics		
or MATH 565	Monte Carlo Methods in Finance		
CS 539	Game Theory: Algorithms and Applications		3
or CS 583	Probabilistic Graphical Models		
or MBA 505	Contemporary Economic Analysis and Game Theory		
or MATH 522	Mathematical Modeling		
CS 538	Combinatorial Optimization		3
or MATH 535	Optimization I		
Computing Sciences Electives			(3)
Select a minimum of one course from the following:			3
CS 422	Data Mining	3	
CS 425	Database Organization	3	
CS 520	Data Integration, Warehousing, and Provenance	3	
CS 522	Advanced Data Mining	3	
CS 525	Advanced Database Organization	3	
CS 529	Information Retrieval	3	
CS 584	Machine Learning	3	
CS 595	Topics in Computer Science	3-12	
CS 597	Reading and Special Problems	1-20	
Applied Math Electives			(3)
Select a minimum of one course from the following:			3
MATH 485	Introduction to Mathematical Finance	3	

MATH 522	Mathematical Modeling	3	
MATH 553	Discrete Applied Mathematics I	3	
MATH 554	Discrete Applied Mathematics II	3	
MATH 569	Statistical Learning	3	
MATH 574	Bayesian Computational Statistics	3	
MATH 597	Reading and Special Projects	1-20	
Business and Application Electives			(3)
Select a minimum of one course from the following:			3
BUS 510	Building an Innovative and Sustainable Business	3	
CAE 581	Algorithms in Transportation	3	
MBA 504	Analytics for Decision Making	3	
MBA 513	Operations and Technology Management	3	
MBA 526	Sustainable Supply Chain Management	3	
MSC 511	Economics I	3	
MSC 514	Economics II	3	
Research			(0-5)
Select 0-5 credit hours			0-5
CS 591	Research and Thesis of Masters Degree	1-5	
or MATH 591	Research and Thesis M.S.		
Additional Computational Decision Science and Operations Research Electives			(6-11)
Select 6-11 credit hours [1]			6-11

Minimum degree credits required: 32

1 Courses listed under core courses may be used as an elective if it is not used to fulfill a core requirement. Note: CS 538 and MATH 535 cannot both be taken for credit.
A maximum of 5 credit hours of CS 597 or MATH 597 may be used towards the elective requirement.

Doctor of Philosophy in Applied Mathematics

The Doctor of Philosophy in Applied Mathematics program provides advanced education through coursework (including independent study) and original, creative research in order to prepare students for careers in industrial research and academia.

Curriculum

Core Courses			(15)
A minimum GPA of 3.25 is required in the core courses.			
MATH 500	Applied Analysis I		3
MATH 577	Computational Mathematics I		3
Select a minimum of three courses from the following:			9
MATH 501	Applied Analysis II	3	
MATH 540	Probability	3	
MATH 553	Discrete Applied Mathematics I	3	
MATH 563	Mathematical Statistics	3	
MATH 578	Computational Mathematics II	3	
Concentration Outside of Math			(6-12)
Select two to four classes			6-12
General Electives			(9-27)
Select 9 to 27 credits [1]			9-27
Ph.D. Research			(24-36)
MATH 691	Research and Thesis Ph.D.		24-36
Math Seminar			(0)
MATH 593	Seminar in Applied Mathematics [2]		0

Minimum degree credits required: 72

1. The remaining courses in each student's program are selected in consultation with, and approval of, the director of graduate studies. The program may include at most three courses at the 400-level and at most two courses outside the department.
2. Students must take the colloquium/seminar course MATH 593 at least six times with a satisfactory grade.

Students must past three written qualifying exams at the Ph.D. level on: MATH 500 Applied Analysis I, MATH 577 Computational Mathematics I, and one of the following: MATH 540 Probability, MATH 553 Discrete Applied Mathematics I, or MATH 563 Mathematical Statistics.

Students must pass one qualifying exam by the end of their third semester, and must pass all three by the end of their fifth semester. Students can attempt each exam twice, if needed. The exams will be offered twice every year, one in the fall and the other in spring. Students can take one, two, or three exams each semester.

Besides the courses in the core areas of study, the remaining courses in the program are selected in consultation with the student's academic adviser. The program may include at most three MATH courses at the 400-level. The program requires the student take the colloquium/seminar course MATH 593 at least six times with a satisfactory grade. The program must include at least two to four courses in an area of concentration outside of the department, as approved by the director of graduate studies; these may include 400-level courses.

The comprehensive examination consists of an oral examination based on the student's research proposal. The exam aims to ensure that the student has the background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit.

The dissertation (thesis) is expected to contain a distinct and substantial, original, and publishable contribution to the field of study. The credit hours devoted to thesis research (MATH 691) must total between 24 and 36. An oral examination in defense of the thesis constitutes completion of the degree.

Exceptions to these general rules require approval by the departmental graduate studies committee.

Biology

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Chair
Thomas Irving

Associate Chair
Tanya Bekyarova

Faculty with Research Interests
For more information regarding faculty visit the Department of Biology website.

The Department of Biology offers B.S., M.S., and Ph.D. degrees in the fields of biology, molecular biochemistry, and biophysics. Within the department, there are many opportunities for interdisciplinary education and research experiences; students in any of the disciplines have easy access to the expertise that the full faculty brings. In addition, the department offers several professional master's degrees and related certificate programs for part-time students, both on campus and through distance learning.

Research Facilities

The department has state-of-the-art computer and laboratory equipment and conducts research in the areas of biochemistry, bioinformatics, cell and molecular biology, microbiology, molecular biophysics and biochemistry. In addition, the department constructs and operates facilities for x-ray scattering and imaging at the Advanced Photon Source at Argonne National Laboratory. The department offers graduate programs leading to M.S. and Ph.D. degrees in biology, concentrating educational and research activities in the areas of biochemistry, bioinformatics, cell and molecular biology, and microbiology. Graduate education in biology is available on either a full- or a part-time basis. Master's degree programs are designed so that they may be completed by part-time students. Specific programs can be completed entirely online. Each new graduate student is assigned a graduate student adviser and must obtain the approval of the adviser each semester before registering for any graduate classes.

Departmental Graduate Examinations

All full-time students in the M.S. and Ph.D. programs are required to take and pass the written M.S. comprehensive/Ph.D. qualifying examination by the end of their fourth semester of study. Part-time students must pass this examination by a comparable stage of their programs. The examination is offered twice each academic year. A student may sit officially for the examination a maximum of two times. Students passing this examination at the Ph.D. level are judged to be qualified to continue in the Ph.D. program. Students passing at the master of science level or above may obtain their master's degree after completing the requirements described in the following sections. All students in the Ph.D. program who have passed the written qualifying examination must take and pass a comprehensive examination before the end of the sixth semester of full-time study. Part-time students must pass this examination by a comparable stage of their programs. This examination consists of a written proposal, an oral presentation, and a defense of the proposal before a faculty committee. A student may take this examination a maximum of two times. Students passing this examination may continue with their research and will receive a Ph.D. upon satisfactory completion of all other required courses and general requirements of the Graduate College, a written dissertation, and final oral thesis defense.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0
TOEFL minimum: 550/213/80[1]

The Graduate Record Examination (GRE) is required for all applicants. The GRE minimum scores are:

Master's Programs

305 (quantitative + verbal); 2.5 (analytical writing)

Ph.D.

310 (quantitative + verbal); 3.0 (analytical writing)

Applicants to the doctoral program in molecular biochemistry and biophysics are strongly encouraged to take one of the subject exams in biology, molecular biology, chemistry, or physics.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Applicants to one of the department's programs (biology or molecular biochemistry and biophysics) are expected to have a bachelor's degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the MAS and M.S. comprehensive/Ph.D. qualifying examination.

[1] Paper-based/computer-based/internet-based test score.

Degrees Offered

Course Descriptions

BIOL 501
Graduate Laboratory Techniques
This course will provide training in biological laboratory techniques. This will include basic laboratory protocols, safety, record keeping, proper use of equipment, and fundamental techniques common to many sub-specializations.
Lecture: 0 **Lab:** 3 **Credits:** 2

BIOL 503
Virology
This course will cover topics related to animal viruses including the life cycles of major viral classes, viral pathogenesis, emergence, and control. Recent advances in these areas will be discussed in conjunction with readings from the original literature.
Prerequisite(s): [(BIOL 445) OR (BIOL 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 504
Biochemistry
Molecules of biological significance; reaction thermodynamics and kinetics; metabolism; cellular localization of biochemical function; proteins; nucleic acids; transcription; translation.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 511
Project Management: Business Principles
Introduction to concepts and techniques used to design and/or analyze a project to develop a set of tasks to accomplish the project, to coordinate and to monitor the work involved in the tasks, and to deliver a final product or service. Budgetary considerations will also be discussed.
Lecture: 2 **Lab:** 0 **Credits:** 2

BIOL 512
Advanced Biochemistry
This course provides an advanced view of modern biochemistry building on studies done in BIOL 504 of metabolism, enzyme mechanisms, and kinetics, as well as theoretical aspects of various laboratory techniques used in biochemistry. Instructor permission required.
Prerequisite(s): [(BIOL 504)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 514
Toxicology
Initial lectures cover basic principles in chemical toxicity, such as dose response, indices of numerical toxicity, metabolism and factors influencing toxicity. Mechanisms of organic toxicity will be presented to include central nervous system, liver, kidney, respiratory system, reproductive system and the hematological system. Special topic lectures will emphasize the mechanism of toxicity for specific metals, pesticides, solvents and substances of abuse.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 515
Molecular Biology
A survey of topics including structure of nucleic acids, translation, transcription, replication, organization of DNA, RNA processing, genomics, and control of gene expression.
Prerequisite(s): [(BIOL 401)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 520
Laboratory Rotation
Independent study in the research laboratory of a faculty member.
Lecture: 0 **Lab:** 9 **Credits:** 3

BIOL 522
Research Techniques in the Biological Sciences I
Experimental techniques in biochemistry, cell Biology, biotechnology, and microbiology are offered as discreet modules. Students select appropriate modules to complement other laboratory courses. Thus a student who has completed, for example, BIOL 533, (Laboratory in Cell and Molecular Biology) would select two modules chosen from cell biology, biotechnology, or microbiology. A written report is required at the completion of each module. Instructor permission required.
Lecture: 1 **Lab:** 6 **Credits:** 3

BIOL 523
Research Techniques in Biological Sciences II
This course is a continuation of BIOL 522 where students have to complete the research project started in BIOL 522 and a write a report in the form of a scientific paper.
Lecture: 0 **Lab:** 3 **Credits:** 3

BIOL 524
Science and Law: An Introduction to Intellectual Property Law and Patents
This course focuses on the interaction of science and law, specifically intellectual property. Topics will include patents, the ethical and legal issues involved with gene patenting, inventorship and collaborations, trade secrets, and the legal system as it relates to intellectual property.
Lecture: 2 **Lab:** 0 **Credits:** 2

BIOL 526
Developmental Biology
This course covers the cellular and molecular processes involved in generating an embryo, in creating various tissues and organs, and the effect of external stimuli on development. Topics include: genome structure, gene expression and regulation, cell cycle control, pattern formation, signal transduction, gametogenesis, organogenesis, and methods used in studying developmental biology. In addition to studies of model organisms, examples relevant to human diseases are covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 527
Immunology and Immunochemistry
Basic concepts of immunology, immunochemistry, both biological and molecular.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 530
Human Physiology
This course is designed to provide the students with comprehensive knowledge about how the human body functions. It will cover cell physiology, autonomic nervous system, neurophysiology, acid base physiology, cardiovascular physiology, respiratory physiology, renal physiology, gastrointestinal physiology, endocrine physiology, and reproductive physiology. Credits cannot be earned to both BIOL 430 and BIOL 530.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 533
Advanced Graduate Laboratory Techniques
This course covers a number of essential techniques in cell and molecular biology, biochemistry, and structural biology with emphases on both the methodologies and the experimental details. Laboratory procedures include cell culture skills and relevant laboratory procedures. This course is arranged modules from which students choose according to their areas of specialization.
Prerequisite(s): [(BIOL 501 with min. grade of B)]
Lecture: 0 **Lab:** 9 **Credits:** 3

BIOL 542
Advanced Microbiology
This course surveys a variety of topics regarding the biology of microbes. These include cell structure, metabolism, physiology, strategies for obtaining energy, and how this relates to microbial ecology, genetics, and comparative genomics.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 544
Molecular Biology of Cells
This is a graduate-level cell biology course. The course contains two parts: initial lectures cover cellular structure and function emphasizing the molecular components, organelles, and regulation of cellular processes; the second part covers special topics emphasizing experimental approaches and molecular mechanisms of cellular regulation.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 545
Advanced Cell Biology
This course is a continuation of BIOL 544 and focuses on recent advances in the area of cell biology. The course covers, in depth, eukaryotic cellular processes, structure-function relationships, and cellular signaling networks in response to physiological and pathological stimuli. The course will also cover frontier topics in the area of cell biology. Emphasis will be on experimental approaches. Instructor permission required.
Prerequisite(s): [(BIOL 445 and BIOL 446) OR (BIOL 533 and BIOL 544)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 550
Bioinformatics
This course is tailored for life science graduates having little to no prior knowledge of Unix/Linux-like operating systems. Topics covered will include Linux/UNIX-like operating systems, the Bash shell, Perl programming, collecting and storing sequences in the lab, multiple sequence alignments, database searching for similar sequences, gene prediction, genome analysis, and phylogenetic prediction.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 555
Macromolecular Structure
Macromolecular crystallographic methods, including crystallization, data processing, phasing, and structure refinement, multi-dimensional NMR techniques, spectroscopic techniques, structural comparisons and characterizations, fiber diffraction, and solution scattering. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 562
Current Topics in Functional Genomics
This course is designed to give students a foundation in advanced theoretical and applied methods in modern molecular research. It will emphasize both established and novel approaches to solving problems of functional and comparative genomics, and systems biology. It will also focus on applications of advanced molecular techniques in areas of significant economic and biomedical importance.
Prerequisite(s): [(BIOL 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 572
Literature in Biochemistry
A topic from the current literature in biochemistry is selected by students for preparation of a paper. Instructor permission required.
Lecture: 0 **Lab:** 0 **Credits:** 3

BIOL 574
Literature in Biotechnology
A topic from the current literature in biotechnology is selected by students for preparation of a paper. Instructor permission required.
Lecture: 0 **Lab:** 0 **Credits:** 3

BIOL 576
Literature in Cell and Molecular Biology
A topic from the current literature in cell and molecular biology is selected by students for preparation of a paper. Instructor permission required.
Lecture: 0 **Lab:** 0 **Credits:** 3

BIOL 578
Literature in Microbiology
A topic from the current literature in microbiology is selected by students for preparation of a paper. Instructor permission required.
Lecture: 0 **Lab:** 0 **Credits:** 3

BIOL 581
Capstone
In this course, students will be provided with the opportunity to perform a research project that is the culmination of their Master's education. This course involves the research and preparation of a group project. Students will develop a formal work reflecting integration of the scientific knowledge and technical skills learned in the Master's programs through a project chosen by the group. The course will explore online collaboration tools to allow participation of online students. Each group will present its Capstone project at the end of the class. Instructor consent is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

BIOL 584
Graduate Seminar in Biology
To foster scientific communication skills, students are required to present seminars based on the scientific literature.
Lecture: 0 **Lab:** 0 **Credits:** 1

BIOL 591
Research and Thesis M.S.
Instructor permission required.
Credit: Variable

BIOL 594
Research Problems
Instructor permission required.
Credit: Variable

BIOL 595
Biology Colloquium
Lectures by invited scientists in areas of biology generally not covered in the department.
Lecture: 0 **Lab:** 0 **Credits:** 1

BIOL 597
Special Problems
Special problems in biology. Instructor permission required.
Credit: Variable

BIOL 600
Continuation of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

BIOL 691
Research and Thesis PHD
Research and Thesis for Ph. D. students.
Credit: Variable

SCI 511
Project Management
Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 522
Public Engagement for Scientists
This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

Master of Biology

The professional Master of Biology is a course-only, professional master's degree program designed for professionals who seek advanced and specialized study in the field without the requirement of a thesis or project.

This program is also available on the web, and at televised viewing sites throughout the Chicago area. Students should consult online.iit.edu for more information.

Curriculum

Students must pass the written comprehensive examination (see Departmental Graduate Examinations (p. 226)) in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology. Students in biotechnology may choose any of the three examinations.

Specialization Courses			(12)
Select 12 credit hours appropriate to specialization [1]			12
Communications Courses			(8-9)
CHEM 513	Statistics for Analytical Chemists		3
COM 421	Technical Communication		3
or COM 523	Communicating Science		
or SCI 522	Public Engagement for Scientists		
SCI 511	Project Management		2-3
or INTM 511	Industrial Leadership		
or BIOL 524	Science and Law: An Introduction to Intellectual Property Law and Patents		
Colloquium Course			(1)
BIOL 595	Biology Colloquium		1
Elective Courses			(8-9)
Select 8-9 credit hours from the following courses:			8-9
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 503	Virology	3	
BIOL 514	Toxicology	3	
BIOL 520	Laboratory Rotation	3	
BIOL 526	Developmental Biology	3	
BIOL 527	Immunology and Immunochemistry	3	
BIOL 542	Advanced Microbiology	3	
BIOL 545	Advanced Cell Biology	3	
BIOL 550	Bioinformatics	3	
BIOL 555	Macromolecular Structure	3	
BIOL 562	Current Topics in Functional Genomics	3	
BIOL 597	Special Problems [2]	1-3	

1 Courses required for each specialization are listed below.

2 Student may be approved for special problems as appropriate.

Minimum degree credits required: 30

Specializations

Biochemistry

BIOL 504	Biochemistry	3
BIOL 512	Advanced Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 544	Molecular Biology of Cells	3
Total Credit Hours		12

Biotechnology

BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 544	Molecular Biology of Cells	3
BIOL 562	Current Topics in Functional Genomics	3
Total Credit Hours		12

Cell and Molecular Biology

BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 526	Developmental Biology	3
BIOL 544	Molecular Biology of Cells	3
Total Credit Hours		12

Microbiology

BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 542	Advanced Microbiology	3
BIOL 544	Molecular Biology of Cells	3
Total Credit Hours		12

Master of Science in Biology

Comprehensive examination
Option 1: Thesis
Option 2: Library or laboratory research project

A Master of Science in Biology student must complete 32-34 credit hours of approved graduate work. This will include 26-30 credit hours of coursework and two credit hours of BIOL 595 Colloquium. Two options are available to complete the M.S. degree requirements: a thesis option and a non-thesis option.

Thesis Option

The thesis option is designed for individuals planning careers as experimental biologists, including those who may wish to pursue a Ph.D. This option is available on a competitive basis. Students choosing the thesis option must complete six credit hours of thesis research (BIOL 591). Students must also prepare a written thesis based on laboratory research.

Non-Thesis Option

The non-thesis option is intended as a degree to meet the needs of teachers, science administrators, policy makers in the life sciences, patent attorneys, and others.

Students who elect the non-thesis option must complete a research project in one of the following courses:

Capstone		(3)
BIOL 581	Capstone	3
Laboratory Research Project		(6)
BIOL 522 & BIOL 523	Research Techniques in the Biological Sciences I and Research Techniques in Biological Sciences II	6

Curriculum

Required Courses			(16)
BIOL 501	Graduate Laboratory Techniques		2
BIOL 504	Biochemistry		3
BIOL 515	Molecular Biology		3
BIOL 533	Advanced Graduate Laboratory Techniques		3
BIOL 544	Molecular Biology of Cells		3
BIOL 595	Biology Colloquium		1
BIOL 595	Biology Colloquium		1
Research Course Requirements			(6)
Select one of the following options:			6
Option 1			
BIOL 581	Capstone	3	
Select one additional elective		3	
Option 2			
BIOL 522 & BIOL 523	Research Techniques in the Biological Sciences I and Research Techniques in Biological Sciences II	6	
Option 3			
BIOL 591	Research and Thesis M.S.	6	
Elective Courses			(10-12)
Select 10-12 credit hours			10-12
Any 500-level biology course		3	
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
Total Credit Hours			32-34

[1] Student may be approved for special problems as appropriate.

Master of Science in Biology for the Health Professions

Comprehensive examination

The purpose of this program is to accommodate the needs of students wishing to improve their qualifications for admission to health-related professional schools such as medicine, dentistry, optometry, and pharmacy by providing advanced training in biology leading to a master of science degree. The program is designed so that it is possible to take the program entirely online, either by full-time or part-time study. Students wishing to acquire advanced hands-on laboratory experience may do so by taking the suggested laboratory courses as electives.

Curriculum

The degree will require 32 credit hours, with 22 credit hours of required courses and the remainder elective courses. Up to 9 credit hours of electives may be 400-level coursework. No more than 9 credit hours may be non-biology courses.

Required Courses		(22)
BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 526	Developmental Biology	3
BIOL 527	Immunology and Immunochemistry	3
BIOL 530	Human Physiology	3
BIOL 542	Advanced Microbiology	3
BIOL 544	Molecular Biology of Cells	3
BIOL 595	Biology Colloquium	1

Elective Courses			(10)
Select 10 credit hours			10
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 431	Animal Physiology Laboratory	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
BME 533	Biostatistics	3	
CHEM 513	Statistics for Analytical Chemists	3	
COM 421	Technical Communication	3	
COM 428	Verbal and Visual Communication	3	
COM 435	Intercultural Communication	3	
COM 523	Communicating Science	3	
COM 577	Communication Law and Ethics	3	
FDSN 501	Nutrition, Metabolism, and Health	3	
PSYC 411	Medical Aspects of Disabling Conditions	3	
PSYC 502	Social Bases of Behavior	3	
SCI 522	Public Engagement for Scientists	3	
Any 500-level biology course		3	
Total Credit Hours			32

1 Student may be approved for special problems as appropriate.

Master of Science in Biology with Specialization in Applied Life Sciences

Comprehensive examination
No thesis option

The requirements for admission to this program include:

- Graduate Record Examination (GRE) minimum scores: 305 (quantitative + verbal), 2.5 (analytical writing)

Curriculum

Required Courses			(18)
BIOL 504	Biochemistry		3
BIOL 515	Molecular Biology		3
BIOL 524	Science and Law: An Introduction to Intellectual Property Law and Patents		2
BIOL 544	Molecular Biology of Cells		3
BIOL 581	Capstone		3
BIOL 595	Biology Colloquium		1
CHEM 513	Statistics for Analytical Chemists		3
Elective Courses			(14)
Select 14 credit hours			14
Any 500-level biology course		3	
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 431	Animal Physiology Laboratory	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
CHEM 518	Understanding the International Conference on Harmonization Guidelines	3	
CHEM 519	Good Manufacturing Practices	3	
SCI 511	Project Management	3	

SCI 522	Public Engagement for Scientists	3	
Total Credit Hours			32

[1] Student may be approved for special problems as appropriate.

Up to 9 hours of 400-level coursework may fulfill elective course requirements per adviser approval.

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Biology with Specialization in Biochemistry

32-34 credit hours

The requirements for admission to this program include:

- one year of physical chemistry in addition to the usual requirements for admission to graduate study in biology

Curriculum

Required Courses			(21)
BIOL 501	Graduate Laboratory Techniques		2
BIOL 504	Biochemistry		3
BIOL 512	Advanced Biochemistry		3
BIOL 515	Molecular Biology		3
BIOL 533	Advanced Graduate Laboratory Techniques		3
BIOL 544	Molecular Biology of Cells		3
BIOL 555	Macromolecular Structure		3
or CHEM 505	Spectroscopic Methods I		
BIOL 595	Biology Colloquium		1
Research Course Requirements			(6)
Select one of the following options:			6
Option 1			
BIOL 581	Capstone	3	
Select one additional elective		3	
Option 2			
BIOL 522 & BIOL 523	Research Techniques in the Biological Sciences I and Research Techniques in Biological Sciences II	6	
Option 3			
BIOL 591	Research and Thesis M.S.	6	
Elective Courses			(5-6)
Select 5-6 credit hours			5-6
Any 500-level biology course		3	
BIOL 410	Medical Microbiology	3	
BIOL 415	Advanced Human Genetics	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
Total Credit Hours			32-33

[1] Student may be approved for special problems as appropriate.

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Biology with Specialization in Cell and Molecular Biology

Curriculum

Required Courses			(21)
BIOL 501	Graduate Laboratory Techniques		2
BIOL 504	Biochemistry		3
BIOL 515	Molecular Biology		3
BIOL 526	Developmental Biology		3
BIOL 533	Advanced Graduate Laboratory Techniques		3
BIOL 544	Molecular Biology of Cells		3
BIOL 545	Advanced Cell Biology		3
or BIOL 527	Immunology and Immunochemistry		
BIOL 595	Biology Colloquium		1
Research Course Requirements			(6)
Select one of the following options:			6
Option 1			
BIOL 581	Capstone	3	
Select one additional elective		3	
Option 2			
BIOL 522 & BIOL 523	Research Techniques in the Biological Sciences I and Research Techniques in Biological Sciences II	6	
Option 3			
BIOL 591	Research and Thesis M.S.	6	
Elective Courses			(5-6)
Select 5-6 credit hours			5-6
Any 500-level biology course		3	
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
Total Credit Hours			32-33

1 Students may be approved for special problems as appropriate.

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Biology with Specialization in Microbiology

Curriculum

Required Courses		(21)
BIOL 501	Graduate Laboratory Techniques	2
BIOL 503	Virology	3
or BIOL 550	Bioinformatics	
BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 533	Advanced Graduate Laboratory Techniques	3
BIOL 542	Advanced Microbiology	3
BIOL 544	Molecular Biology of Cells	3
BIOL 595	Biology Colloquium	1
Research Course Requirements		(6)

Select one of the following options:			6
Option 1			
BIOL 581	Capstone	3	
Select one additional elective		3	
Option 2			
BIOL 522 & BIOL 523	Research Techniques in the Biological Sciences I and Research Techniques in Biological Sciences II	6	
Option 3			
BIOL 591	Research and Thesis M.S.	6	
Elective Courses			(5-7)
Select 5-7 credit hours			5-7
Any 500-level biology course		3	
BIOL 410	Medical Microbiology	3	
BIOL 415	Advanced Human Genetics	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 440	Neurobiology	3	
BIOL 514	Toxicology	3	
BIOL 597	Special Problems [1]	1-3	
Total Credit Hours			32-34

[1] Student may be approved for special problems as appropriate.

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Molecular Biochemistry and Biophysics

32 credit hours
Comprehensive examination
Option 1: Thesis
Option 2: Library or laboratory research project

Curriculum

A master's student must complete 32 credit hours of approved graduate work, including a core of 20 credit hours, 1 hour of BIOL 595, 5-6 credit hours of approved electives, and 6 credit hours of research toward the thesis (BIOL 591); or BIOL 581 and one additional elective, or BIOL 522 and BIOL 523.

Required Courses			(21)
BIOL 501	Graduate Laboratory Techniques		2
BIOL 504	Biochemistry		3
BIOL 512 or PHYS 410	Advanced Biochemistry Molecular Biophysics		3
BIOL 515	Molecular Biology		3
BIOL 533	Advanced Graduate Laboratory Techniques		3
BIOL 544	Molecular Biology of Cells		3
BIOL 555	Macromolecular Structure		3
BIOL 595	Biology Colloquium		1
Research Course Requirements			(6)
Select one of the following options:			6
Option 1			
BIOL 581	Capstone	3	
Select one additional elective		3	
Option 2			
BIOL 522 & BIOL 523	Research Techniques in the Biological Sciences I and Research Techniques in Biological Sciences II	6	

Option 3			
BIOL 591	Research and Thesis M.S.	6	
Elective Courses			(5-6)
Select 5-6 credit hours from the following:			5-6
Any 500-level biology course			
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
Total Credit Hours			32-33

[1] Student may be approved for special problems as appropriate.

The elective is chosen in consultation with an academic adviser. Research for the dissertation must be carried out under the direct supervision of a participating faculty member; the faculty research adviser also acts as the candidate's academic adviser.

Thesis Option

The thesis option is designed for individuals planning careers as experimental biologists, including those who may wish to pursue a Ph.D. This option is available on a competitive basis. Students choosing the thesis option must complete 6 credit hours of thesis research (BIOL 591, CHEM 591, or PHYS 591). Students must also prepare a written thesis based on laboratory research.

Non-Thesis Option

The non-thesis option is intended as a degree to meet the needs of teachers, science administrators, policy makers in the life sciences, patent attorneys, and others. Students who elect the non-thesis option must complete a library research project in BIOL 572, or BIOL 581, or a laboratory based research project in BIOL 522 plus BIOL 523.

Doctor of Philosophy in Biology

Curriculum

A minimum of 72 credit hours is required for the Ph.D. degree in biology. Students should consult the Transfer Credit section (p. 476) in this bulletin for rules on how many credit hours may be transferred from another institution. Completion of an M.S. degree is not normally required for admission to the full-time program for the Ph.D. degree but may be required of part-time students. Students must pass the Ph.D. written qualifying examination in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology (see Departmental Graduation Examinations (p. 226)).

Each student, in addition, will be required to pass a comprehensive examination taken prior to performing the major portion of the dissertation research, and in any event, prior to the sixth semester of study and at least one year before oral defense of the thesis. The final examination for the Ph.D. degree consists of an oral presentation and defense of the dissertation.

The Ph.D. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the plan of study (Form G401). Plans of study may be designed in any of the three areas of concentration. However, all programs of study must include at least 36 credit hours in formal courses (exclusive of BIOL 591 and BIOL 691).

Formal courses must include the core courses listed below:

Required Courses			(13)
BIOL 504	Biochemistry		3
BIOL 515	Molecular Biology		3
BIOL 544	Molecular Biology of Cells		3
BIOL 595	Biology Colloquium (4 times)		4
Elective Courses			(23-35)
Select 23 to 35 hours			23-35
BIOL 410	Medical Microbiology	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 503	Virology	3	
BIOL 514	Toxicology	3	
BIOL 520	Laboratory Rotation	3	
BIOL 526	Developmental Biology	3	
BIOL 527	Immunology and Immunochemistry	3	
BIOL 542	Advanced Microbiology	3	
BIOL 545	Advanced Cell Biology	3	
BIOL 550	Bioinformatics	3	
BIOL 555	Macromolecular Structure	3	
BIOL 562	Current Topics in Functional Genomics	3	
BIOL 597	Special Problems	1-20	
PHYS 410	Molecular Biophysics	3	
Ph.D. Research			(24-36)
BIOL 691	Research and Thesis PHD		24-36

Minimum degree credits required: 72

All research for the dissertation must be carried out under the direct supervision of a faculty research adviser. The faculty research adviser will also act as the candidate's academic adviser. Students must have passed the written qualifying examination before registering for BIOL 691. Students may complete all formal course requirements for the Ph.D. degree as either full-time or part-time students.

Doctor of Philosophy in Molecular Biochemistry and Biophysics

Curriculum

A minimum of 72 credit hours of instruction is required for the MBB Ph.D. program. Students should consult the Transfer Credits section (p. 476) for rules on how many credit hours may be transferred from another institution. Completion of an M.S. degree is not normally required for admission to the Ph.D. program. Students must complete 22 credit hours of core courses and at least three additional courses from the list of electives.

Each graduate student must take and pass the written Ph.D. qualifying examination in order to enter into candidacy for the doctorate. Each student, in addition, will be required to pass a comprehensive examination taken prior to performing the major portion of the dissertation research, and in any event, prior to the sixth semester of study and at least one year before oral defense of the thesis. The final examination for the Ph.D. degree consists of an oral presentation and defense of the dissertation.

The Ph.D. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the plan of study (Form G401). The plan of study must include at least 36 credit hours in formal courses (exclusive of BIOL 591 and BIOL 691).

All students will be required to take the following courses, or have equivalent background:

Required Courses			(22)
BIOL 504	Biochemistry		3
BIOL 512	Advanced Biochemistry		3
BIOL 515	Molecular Biology		3
BIOL 544	Molecular Biology of Cells		3
BIOL 555	Macromolecular Structure		3
BIOL 595	Biology Colloquium (4 times)		4
PHYS 410	Molecular Biophysics		3
MBB students, in consultation with their academic adviser, choose the remainder of their formal coursework from the following list of elective courses:			
Elective Courses			(14-26)
Select 14-26 credit hours			14-26
BIOL 410	Medical Microbiology	3	
BIOL 415	Advanced Human Genetics	3	
BIOL 426	Concepts of Cancer Biology	3	
BIOL 430	Human Physiology	3	
BIOL 440	Neurobiology	3	
BIOL 597	Special Problems [1]	1-3	
CHEM 538	Physical Biochemistry	3	
Any 500-level biology course		3	
Ph.D. Research			(24-36)
BIOL 691	Research and Thesis PHD		24-36

Minimum degree credits required: 72

1 Student may be approved for special problems as appropriate.

Other courses may be prescribed by the adviser/thesis committee according to the student's individual needs for the plan of study.
All research for the dissertation must be carried out under the direct supervision of a faculty research adviser who will also act as the candidate's academic adviser.

Chemistry

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science.iit.edu/chemistry

Interim Chair
Carlo Segre

Associate Chair
Rong Wang

Faculty with Research Interests
For more information regarding faculty visit the Department of Chemistry website.

The Department of Chemistry offers graduate programs leading to the M.S. and Ph.D. degrees in chemistry. Each student's program is planned individually to meet individual needs, interests, and capabilities. In addition, the department offers two professional master's programs designed for part-time students and available through distance learning. The aim of these programs is to develop chemists who are able to think creatively and critically.

Each new graduate student is assigned a graduate student adviser and must obtain the approval of the adviser each semester before registering for any classes.

Research Centers

International Center for Sensor Science and Engineering (ICSSE)

Research Facilities

The department has state-of-the-art computer and laboratory equipment and conducts research in the areas of analytical chemistry, biological chemistry, computational chemistry, inorganic chemistry, materials chemistry, organic chemistry, polymer chemistry, surface chemistry, physical chemistry, and medicinal chemistry. The department has a strong collaboration with Argonne National Laboratory that provides access to an array of advanced research and instrumentation facilities. On-campus research facilities include x-ray diffraction facilities, a high-field nuclear magnetic resonance facility, state-of-the-art inorganic-, organic- and polymer synthesis and characterization laboratories, Fourier transform infrared spectrometers, atomic force microscope, mass spectrometers, facilities for high-pressure liquid chromatography and gas chromatography, and high-performance computer clusters. Collaborative programs are carried on with Argonne National Laboratory and the Advanced Photon Source. The department is home to ICSSE, whose mission is to bring researchers from academia, industry, and research labs together to provide an interdisciplinary environment for broader areas of sensor research.

Department Graduate Examinations

All full-time students in the M.S. and Ph.D. programs are required to take and pass the oral M.S. comprehensive/Ph.D. qualifying examination after completing the core course requirement and by the end of their fourth semester of study. Part-time students must pass this examination by a comparable stage of their programs. This examination consists of a presentation before a faculty committee about a recent research paper. It may be taken up to once per semester and a maximum of two times. After the presentation, the committee will evaluate the student's performance on coursework, research, and the oral examination and judge whether the student has passed at the Ph.D. level, M.S. level, MCH level, or failed. Students passing this examination at the Ph.D. level are judged to be qualified to continue in the Ph.D. program. Students passing at the M.S. level or above may obtain their M.S. degree after completing the requirements described in the following sections. Similarly, students passing at the MCH level or above may obtain their MCH degree after completing the requirements described in the following sections.

All students in the Ph.D. program who have passed the oral qualifying examination must take and pass a comprehensive examination at least a year prior to their thesis defense. This examination consists of a written proposal, an oral presentation, and a defense of the proposal before a faculty committee. A student may take this examination a maximum of two times. Students passing this examination may continue with their research and will receive a Ph.D. upon satisfactory completion of all other required courses and general requirements of the Graduate College, a written dissertation, and final oral thesis defense.

All students in the MCH and professional master's degree programs (MAS) are required to take and pass a comprehensive exam. Students may sit for the exam a limited number of times, depending upon the individual program.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0
TOEFL minimum: 550/213/80[1]

The Graduate Record Examination (GRE) is required for all applicants except MAS applicants who have earned an undergraduate degree from an accredited U.S. institution with a GPA of 3.0 or above. The GRE minimum scores are:

Ph.D.

310 (quantitative + verbal); 3.0 (analytical writing)

MCH or M.S.

300 (quantitative + verbal); 2.5 (analytical writing)

MAS

GRE is not required if the B.S. degree is granted by an accredited U.S. institution and the GPA is 3.0 or above.
300 (quantitative + verbal), 2.5 (analytical writing)

Applicants to the doctoral program are strongly encouraged to submit the subject-area GRE score (subject no. 27). Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. Applicants are expected to have a bachelor's degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the MCH, MAS, and M.S. comprehensive/Ph.D. qualifying examination.

1 Paper-based/computer-based/internet-based test score.

Degrees Offered

Certificate Programs

Course Descriptions

CHEM 500
Advanced Analytical Chemistry
An overview of analytical chemistry with discussions of complex ionic equilibria, electro analytical techniques including potentiometric, voltametric, coulometric and conductometric methods, ion chromatography, capillary electrophoresis and sensor technology.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 501
Capstone Project
This course will educate students in the area of quality process and quality manufacturing. Student will work with the instructor to plan and conduct research on a project that is relevant to the analytical chemistry program of study. The project must be approved by the Master of Chemistry in Analytical Program Director.
Lecture: 1 **Lab:** 3 **Credits:** 2

CHEM 503
Survey of Analytical Chemistry
This course covers modern aspects of chemical analysis. It is designed to give the student a solid conceptual ground to understand how a given analytical technique works including its limits and advantages. The emphasis is on solutions analysis and the course is roughly divided into: (i) Basic measurements and concepts; (ii) spectroscopy; and (iii) chromatography and mass spectrometry. Upon completion of this course, the student will be able to: describe the basic setup and operation of separation, mass spectrometric, and spectroscopic instrumentation; interpret spectra from various instruments as a means for qualitative and quantitative analysis; apply basic knowledge of separation technique, mass spectrometry, and spectroscopy for practical problem solving; relate the use of separation technique, mass spectrometry, and spectroscopy to his or her own research interests; and compile, present, and explain modern techniques for analytical research. Topics includes high-performance liquid chromatography, gas chromatography, atomic spectrometry, molecular spectrometry, UV/vis spectroscopy, molecular luminescence, infrared spectrometry, mass spectrometry, radio chemistry, raman spectroscopy, nuclear magnetic resonance spectroscopy, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 505
Spectroscopic Methods I
Theories of spectroscopic transitions and their applications in structural elucidations and quantitative analysis. Topics include ultraviolet/visible, infrared, Raman and nuclear magnetic resonance spectroscopy and mass spectrometry.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 506
Sampling and Sample Preparation
Techniques and devices for sampling in diverse media will be treated, followed by a discussion of sample treatment prior to analysis including isolation, concentration, and fractionation of analytes and classes of analytes.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 508
Analytical Methods Development
A seminar course presenting analytical methods in complex matrices with emphasis on methods development and validation.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 509
Physical Methods of Characterization
A survey of physical methods of characterization including x-ray diffraction and fluorescence surface techniques including SEM, TEM, AES and ESCA, thermal methods and synchrotron radiation methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 510
Electronics and Interfacing
Elementary circuit analysis, operational amplifiers, digital electronics, signal processing and interfacing of instruments using modern computer software and hardware.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 512
Spectroscopic Methods II
A continuation of the study of optical methods covering atomic absorption spectroscopy, atomic and flame emission spectroscopy, chemiluminescence, fluorescence, phosphorescence, light scattering and refractometry.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 513
Statistics for Analytical Chemists
A survey providing sufficient statistical background for scientists. The topics covered include probability, statistics, sampling estimation, regression analysis, experimental design, data analysis and signal enhancement.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 515
Gas Chromatography -- Theory and Practice
This course will cover theory and concepts of gas chromatographic analysis and its practical application in solving analytical problems. Topics include basic theory of chromatographic separation, separation dynamics, instrumentation, column selection, quantitative techniques, and practical applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 516
Liquid Chromatography -- Theory and Practice
This course will cover the operating principles and applications of state-of-the-art LC/HPLC instrumentation and analysis. Topics include basic theory of liquid chromatography, instrumentation, optimization of LC separation, quantitative techniques, and the diverse range of analytical applications amenable to LC analysis.
Prerequisite(s): [(CHEM 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 518
Understanding the International Conference on Harmonization Guidelines
The International Conference on Harmonization (ICH) was revolutionized in the 1980's to provide a forum for the pharmaceutical industry to discuss regulatory requirements for registration of new chemical entity. These guidelines have been significantly influenced the content of FDA draft guidelines to develop the scientific information and manufacturing controls. Thus, proper understanding of these guidelines is essential in the drug development process. This course will be designed to focus exclusively on guidelines associated with the registration of small molecules. Completing this course, students will understand the expectations set forth in various FDA and ICH quality topics in order to implement these guidelines and/or engage the regulatory agencies in dialogue in order to provide justification of data or present clear scientific rationale.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 519
Good Manufacturing Practices
This course provides an introduction to current good manufacturing practices (GMP) regulations and their implementation to different areas of the manufacturing process such as laboratory records, equipment, personnel, facilities, etc. The course will help students to recognize the regulatory actions and financial risks for non-compliance.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 520
Advanced Inorganic Chemistry
Selective treatment of the chemistries of main group and transition elements with emphasis on coordination complexes, organometallic compounds and inorganic cages and clusters. Discussions of molecular symmetry, stereochemistry, bonding, electronic spectra, magnetic properties, reactions, kinetics and reaction mechanisms are included.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 521
Structural Inorganic and Materials Chemistry
This course covers structure and bonding and structure-property relationships in inorganic molecules and solids. Descriptions of crystal structures, spectroscopic and x-ray diffraction techniques for structure determination and properties of solids are included.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 522
Efficient Chemical and Materials Synthesis
The design and development of environmentally benign chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 524
Synthesis and Intellectual Property Management
This course focuses on the management of intellectual property. Professionals will lead discussions on the control and dissemination of materials concerning intellectual property. This will be combined with the technical presentations by the students in the classroom. Topics of discussion will include invention disclosures, intellectual property rights, proprietary materials, justification for patents, types of patents, the terms of a patent, patents procedure, licensing procedure and security considerations. Access to patented materials and disclosure of materials under patent process will be covered.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 526
Graduate Chemistry Laboratory
An advanced laboratory with emphasis on synthesis and characterization of inorganic and organometallic compounds.
Lecture: 1 **Lab:** 7 **Credits:** 3

CHEM 530
Organic Reaction Mechanisms
A study of important mechanism classes and their relationship to the major reactions of organic chemistry. Emphasis will be placed on the study of reaction intermediates and on the methods used to characterize reaction pathways. Topics will include chemical bonding, aromaticity, stereochemistry, substitution, elimination, carbanion chemistry, free radical reactions, photochemistry and concerted reactions.
Prerequisite(s): [(CHEM 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 531
Tactics in Organic Synthesis
A study of modern synthetic strategies used in the preparation of complex organic molecules. Synthetic planning using the disconnection approach and the selection of reagents to solve regiochemical and stereo chemical problems will be the underlying themes. Synthetic strategies to be discussed include tandem reactions, template and chelation effects, biomimetic tactics and the use of chiral terpenes, carbohydrates and amino acids in enantioselective syntheses. Target molecules will include natural products, pharmaceuticals and smart organic materials.
Prerequisite(s): [(CHEM 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 534
Advanced Spectroscopic Methods
Characterization and analysis by mass, vibrational, nuclear magnetic resonance, and electronic spectroscopy. Structure spectra correlations applied to organic and inorganic compounds with examples drawn from diverse areas, e.g., pollutants, toxic materials, polymers, etc.
Lecture: 3 **Lab:** 4 **Credits:** 4

CHEM 535
Polymer Synthesis
This course will cover the basics of polymer synthesis including traditional polymerization techniques, such as free-radical and ionic chain polymerizations, and step-growth polymerization. Newer methods of polymer synthesis, such as ring-opening metathesis and controlled free-radical polymerizations, will also be discussed. Students will be introduced to the methods of preparation of advanced polymer structures, such as block, star and brush copolymers, dendrimers, and hyperbranched polymers.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 537
Polymer Chemistry Laboratory
This course will include the synthesis of a variety of polymers and their characterization using instrumental methods. Emphasis will be placed on factors that control polymer formation, methods for obtaining molecular weights and distributions of polymers, as well as thermal and mechanical characteristics of polymers.
Prerequisite(s): [(CHEM 470)]
Lecture: 1 **Lab:** 6 **Credits:** 3

CHEM 538
Physical Biochemistry
The course will cover the principles and techniques of physical chemistry applied to biological macromolecules. Topical concepts include thermodynamics, kinetics, and quantum chemistry. Applications to areas such as interpretation of entropy and enthalpy driven processes, biochemical equilibrium, phase transitions in lipid, bilayers and membranes, enzyme kinetics, intra- and intermolecular interactions, and spectroscopy of proteins and nucleic acids will be introduced.
Prerequisite(s): [(CHEM 239 and CHEM 344)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 539
Introduction to Pharmaceutical Chemistry
Fundamental concepts will be discussed, including modern principles of drug design; drug absorption, distribution and metabolism; theories of drug-receptor interactions; approaches to structure-activity relationships; chemical, physicochemical and structural considerations. The various classes of therapeutic agents will be surveyed with emphasis on possible modes of action. Methods of synthesis will be considered.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 542
Polymer Characterization and Analysis
This course will provide an overview of the common techniques for polymer characterization, studying structure-property relationships, and polymer morphology. The course will focus on thermal and mechanical characterization of polymers as well as polymer rheology. Examples and uses of major commercial polymers and advanced functional polymers will be introduced.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 543
Analytical Chemistry in Pharmaceutical Laboratories
This course is designed to compliment the current curriculum of the professional master degree in analytical chemistry. It is a review of the requirements a student may face as a professional chemist in a regulated industry. The course focus is on the requirements and common topics facing today's pharmaceutical industry. While individual agencies have specific regulations, the fundamental ideas of these regulations are largely consistent across the board. For example, an analytical chemist versed in Good Laboratory Practices (GLP) under FDA can quickly pick up the GLP's required by EPA.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 544
Colloids and Colloid Analysis
This course will begin a general overview of colloid science. This part of the course will introduce various types of colloids, touch on factors and conditions leading to their stability or instability, consider their evolution and will include a very limited discussion of the conditions under which they can form. The second part of the course will consist of a series of discussions of specific analytical techniques used to characterize colloidal systems, with particular emphasis on the physical characterization of the dispersed phase.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 548
Electrochemical Methods
Thermodynamics and potential, charge-transfer kinetics and mass transfer. Potential step and potential sweep methods, including hydrodynamic methods. Bulk electrolysis methods. Electrode reactions coupled with homogeneous chemical reactions. Double-layer structure and absorbed intermediates in electrode processes. Digital simulation of electrochemical processes. Students are expected to have some background in the physical chemistry of solutions and electroanalytical chemistry at the level of CHEM 500.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 550
Chemical Bonding
Review of the postulatory basis of quantum mechanics and application to 1-D and 3-D systems. Hydrogenic and symmetry-adapted spin orbitals and bond formation. Ground and excited states. Commonly used semiempirical molecular orbital methods.
Prerequisite(s): [(CHEM 344)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 552
Chemical Kinetics
Types of reactions, reaction order, activation energy, transition states, isotope effects and the mechanism of reactions. Determination of the rates of free radical reactions. Primary processes in thermal, photochemical and other radiation-induced reactions.
Prerequisite(s): [(CHEM 550 and CHEM 553)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 553
Chemical Statistical Thermodynamics and Molecular Simulation
Statistical interpretation of the fundamental properties and laws of thermodynamics. Ensembles, partition functions, and principles of molecular simulation. Applications to chemical and phase equilibria including case studies from contemporary literature.
Prerequisite(s): [(CHEM 343 and CHEM 344)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 560
Advanced Chemistry Projects
Advanced chemistry projects to be carried out under the direction of a faculty member. These projects may involve computational, theoretical, experimental work or a combination of these. Projects based on experimental work may be carried out in the research lab of the instructor. Topics of the advanced projects will be selected by the faculty member offering the course and will not necessarily be related to the dissertation topic of the student. May be taken more than once and up to 12 credit hours.
Credit: Variable

CHEM 584
Graduate Seminar in Chemistry
To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all first year M.S. and PhD students.
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 585
Chemistry Colloquium
Lectures by invited scientists in areas of chemistry generally not covered in the department. Must be taken two time by M.S. students and four time by PhD. students.
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 591
Research and Thesis
(Credit: Variable)
Credit: Variable

CHEM 594
Special Problems
Designed for non-thesis M.S. only. (Credit: Variable)
Credit: Variable

CHEM 596
Chemistry for Teachers-Elementary
Certification as chemistry teacher or approval of instructor. An in-service workshop for pre-college teachers emphasizing the phenomenological approach to the teaching of chemical science. (Credit: variable)
Credit: Variable

CHEM 597
Reading and Special Problems
Independent study to meet the special needs of graduate students in department-approved graduate degree programs. Requires the written consent of the instructor. May be taken more than once. Receives a letter grade. (Credit: Variable)
Credit: Variable

CHEM 598
Chemistry for High School Teachers
Certification as teacher or approved of instructor. An in-service workshop for pre-college teachers emphasizing the phenomenological approach to teaching of chemical science at the high school level. (Credit: variable)
Credit: Variable

CHEM 600
Continuation of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 610
Special Topics in Analytical Chemistry
Topics of current interest in analytical chemistry including advanced electro-chemistry, surface spectroscopy of electrode surfaces, separations, laboratory automation and new spectroscopic techniques.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 611
Special Topics in Analytical Chemistry
Topics of current interest in analytical chemistry including advanced electro-chemistry, surface spectroscopy of electrode surfaces, separations, laboratory automation and new spectroscopic techniques.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 620
Special Topics in Inorganic Chemistry
Topics of current interest in inorganic chemistry, including organometallic chemistry, homogeneous catalysis, inorganic reaction mechanisms, inorganic stereochemistry, materials chemistry, x-ray crystallography, synthetic and physical methods in inorganic and materials chemistry and chemical applications of group theory.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 621
Special Topics in Inorganic Chemistry
Topics of current interest in inorganic chemistry, including organometallic chemistry, homogeneous catalysis, inorganic reaction mechanisms, inorganic stereochemistry, materials chemistry, x-ray crystallography, synthetic and physical methods in inorganic and materials chemistry and chemical applications of group theory.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 630
Special Topics in Organic Chemistry
Topics of current interest in organic chemistry including photochemistry, fluorine chemistry, heterocyclic chemistry, pharmaceutical chemistry and electro optical organic chemistry.
Prerequisite(s): [(CHEM 455)]
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 631
Special Topics in Organic Chemistry
Topics of current interest in organic chemistry including photochemistry, fluorine chemistry, heterocyclic chemistry, pharmaceutical chemistry and electro optical organic chemistry.
Prerequisite(s): [(CHEM 455)]
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 635
Heterocyclic Chemistry
Of the vast array of structures which organic compounds adopt, many contain ring systems as a component. When the ring is made up of carbon and at least one other element, the compound is classified as a heterocycle. The aims of this course are to identify the effects that the presence of such ring systems have on the chemistry of a molecule; to show how the rings can be made, and to describe some of the uses of the compounds in organic synthesis, in medicine and in other contexts. The chemistry of aromatic five-, six- and seven-membered ring compounds with one or more nitrogen, oxygen and/or sulfur atoms will be emphasized.
Prerequisite(s): [(CHEM 239 and CHEM 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 650
Special Topics in Physical Chemistry
Topics of current interest in physical chemistry, including atmospheric chemistry, ion molecule reactions, laser chemistry, theories of gas phase reactions, scattering theory, interaction of radiation with matter and time-dependent relaxation methods.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 651
Special Topics in Physical Chemistry
Topics of current interests in physical chemistry, including atmospheric chemistry, ion molecule reactions, laser chemistry, theories of gas phase reactions, scattering theory, interaction of radiation with matter and time-dependent relaxation methods.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 684
Graduate Seminars in Chemistry
To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all Ph.D. students who have passed the written qualifying examination.
Lecture: 1 **Lab:** 0 **Credits:** 1

CHEM 685
Chemistry Colloquium
Lectures by invited scientists in areas of chemistry generally not covered in the department.
Prerequisite(s): [(CHEM 585)]
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 691
Research and Thesis Ph.D.
(Credit: Variable) Instructor permission required.
Credit: Variable

SCI 511
Project Management
Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 522
Public Engagement for Scientists
This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

Master of Chemistry

A minimum of 32 credit hours is required for the Master of Chemistry degree. A minimum of 20 credit hours of 500-level coursework is required with 15 credit hours required from the chemistry disciplines. A maximum of 12 credit hours of 400-level coursework may be used to fulfill graduate study requirements. Students seeking the Master of Chemistry degree must pass a written or oral comprehensive examination.

The Master of Chemistry is tailored to fit the student's background and goals and is subject to approval at the time of filing the Plan of Study, when 9 credit hours are earned or in-progress.

Curriculum

Required Courses			(27-28)
CHEM 526	Graduate Chemistry Laboratory		3
CHEM 534	Advanced Spectroscopic Methods		4
CHEM 584	Graduate Seminar in Chemistry		1
CHEM 585	Chemistry Colloquium		1
CHEM 585	Chemistry Colloquium		1
Select a minimum of four core courses from the following:			12
BIOL 504	Biochemistry	3	
CHEM 455	Advanced Organic Chemistry	3	
CHEM 503	Survey of Analytical Chemistry	3	
CHEM 520	Advanced Inorganic Chemistry	3	
CHEM 535	Polymer Synthesis	3	
CHEM 550	Chemical Bonding	3	
Select a minimum of two professional development courses from the following:			5-6
CHEM 524	Synthesis and Intellectual Property Management	2	
INTM 511	Industrial Leadership	3	
SCI 511	Project Management	3	
SCI 522	Public Engagement for Scientists	3	
Elective Courses			(4-5)
Select 4-5 credit hours in consultation with adviser			4-5

Minimum degree credits required: 32

Master of Chemistry in Analytical Chemistry

The professional master's program in analytical chemistry is a part-time program for working chemists seeking to strengthen their understanding of analytical chemistry. The specific goal of the program is to provide the student with a broad and in-depth understanding of state-of-the-art analytical techniques with a firm grounding in separation science, spectroscopy, method development, and sample preparation. In addition, students acquire professional skills in effective communication, statistics, and business principles. Candidates must possess a bachelor's degree (ideally in science or engineering) with at least one semester of calculus, one semester of calculus-based physical chemistry, one semester of analytical chemistry, and two semesters of organic chemistry. Candidates' advisers assist them in determining if any further prerequisites are necessary. A final comprehensive exam is required for graduation. This program is also available via the internet. Students should consult science.iit.edu/programs/graduate/master-chemistry-analytical-chemistry for more information.

Curriculum

Required Courses		(32-33)
CHEM 500	Advanced Analytical Chemistry	3
CHEM 501	Capstone Project	2
CHEM 505	Spectroscopic Methods I	3
CHEM 508	Analytical Methods Development	2
CHEM 509	Physical Methods of Characterization	3
CHEM 512	Spectroscopic Methods II	2
CHEM 513	Statistics for Analytical Chemists	3
CHEM 515	Gas Chromatography -- Theory and Practice	3
CHEM 516	Liquid Chromatography -- Theory and Practice	3

Select a minimum of one course from the following:			2-3
CHEM 506	Sampling and Sample Preparation	3	
CHEM 542	Polymer Characterization and Analysis	3	
CHEM 543	Analytical Chemistry in Pharmaceutical Laboratories	2	
CHEM 544	Colloids and Colloid Analysis	2	
Select a minimum of two courses from the following:			6
INTM 511	Industrial Leadership	3	
SCI 511	Project Management	3	
SCI 522	Public Engagement for Scientists	3	
Total Credit Hours			32-33

Master of Chemistry in Materials Chemistry

The professional master's program in materials chemistry is a part-time program designed for scientists who wish to broaden their background in synthesis, characterization, and properties of materials and chemical systems. The program combines modern materials design and synthesis strategies with innovative characterization techniques, computational and simulation methods, project management, technical communication, and intellectual property management. It is structured to provide students with opportunities to develop a broad understanding of materials synthesis and characterization, to learn to design and manage projects, and to sharpen their intellectual property management.

Candidates seeking admission to this program must have a bachelor's degree (ideally in science or engineering), with at least two semesters of organic chemistry and two semesters of calculus. The academic adviser will assist students in determining whether any prerequisites are necessary. A final comprehensive examination is required for graduation. This program is also available on the web. Students should consult science.iit.edu/chemistry for more information.

Curriculum

Required Courses			(27)
CHEM 454	Chemical Modeling and Simulation		3
CHEM 470	Introduction to Polymers		3
CHEM 505	Spectroscopic Methods I		3
CHEM 509	Physical Methods of Characterization		3
CHEM 521	Structural Inorganic and Materials Chemistry		3
CHEM 522	Efficient Chemical and Materials Synthesis		3
CHEM 535	Polymer Synthesis		3
SCI 511	Project Management		3
SCI 522	Public Engagement for Scientists		3
Elective Courses			(5-6)
Select a minimum of two courses from the following:			5-6
CHEM 513	Statistics for Analytical Chemists	3	
CHEM 524	Synthesis and Intellectual Property Management	2	
CHEM 530	Organic Reaction Mechanisms	3	
CHEM 531	Tactics in Organic Synthesis	3	
CHEM 542	Polymer Characterization and Analysis	3	
Total Credit Hours			32-33

Master of Science in Chemistry

A minimum of 32 credit hours is required for the Master of Science (M.S.) in Chemistry degree. A minimum of 20 credit hours of 500-level coursework is required with 15 credit hours required from the chemistry disciplines. A maximum of 12 credit hours of 400-level coursework may be used to fulfill graduate study requirements.

Students seeking the M.S. in Chemistry degree must pass the oral comprehensive examination by the end of the fourth semester in the program. Students must also register for 6-8 credits of research coursework numbered 591, write a thesis based on original research, and defend it before his or her M.S. thesis committee. The thesis and oral defense should be completed before the end of the third year of academic study.

The M.S. program is tailored to fit the student's background and goals and is subject to approval at the time of filing the Plan of Study, when 9 credit hours are earned or in-progress.

Curriculum

Required Courses			(15)
CHEM 584	Graduate Seminar in Chemistry		1
CHEM 585	Chemistry Colloquium		1
CHEM 585	Chemistry Colloquium		1
Select a minimum four core courses from the following:			12
CHEM 455	Advanced Organic Chemistry	3	
CHEM 503	Survey of Analytical Chemistry	3	
CHEM 520	Advanced Inorganic Chemistry	3	
CHEM 535	Polymer Synthesis	3	
CHEM 550	Chemical Bonding	3	
BIOL 504	Biochemistry	3	
Elective Courses			(9-11)
Select 9-11 credit hours in consultation with adviser			9-11
Thesis Research			(6-8)
CHEM 591	Research and Thesis		6-8

Minimum degree credits required: 32

Doctor of Philosophy in Chemistry

Written qualifying examination
Comprehensive examination
Dissertation and oral defense

A minimum of 72 credit hours is required for the Ph.D. in Chemistry. Students who have received an M.S. degree from another university may petition for transfer of up to 32 credit hours, applicable toward the Ph.D. degree.

Students must pass the Ph.D. qualifying examination by the end of their fourth semester in the program.

Next, students should register for 24-36 credit hours of research coursework numbered 691. To pass the comprehensive examination, students need to write a research progress report and proposal and defend it before a faculty committee. Students must pass the comprehensive exam before the end of their third year.

The final phase in the Ph.D. degree program is the successful oral defense of the dissertation and submission of a Ph.D. dissertation approved by the academic adviser and the thesis committee.

Curriculum

Required Courses			(18)
CHEM 584	Graduate Seminar in Chemistry		1
CHEM 585	Chemistry Colloquium		1
CHEM 585	Chemistry Colloquium		1
CHEM 684	Graduate Seminars in Chemistry		1
CHEM 685	Chemistry Colloquium		1
CHEM 685	Chemistry Colloquium		1
Select a minimum of four core courses from the following:			12
CHEM 455	Advanced Organic Chemistry	3	
CHEM 503	Survey of Analytical Chemistry	3	
CHEM 520	Advanced Inorganic Chemistry	3	
CHEM 535	Polymer Synthesis	3	
CHEM 550	Chemical Bonding	3	
BIOL 504	Biochemistry	3	
Elective Courses			(18-30)
Select 18-30 credit hours in consultation with adviser			18-30
Thesis Research			(24-36)
CHEM 691	Research and Thesis Ph.D.		24-36

Minimum degree credits required: 72

Certificate in Analytical Method Development

Curriculum

Required courses			(9-11)
CHEM 508	Analytical Methods Development		2
Select a minimum of three courses (not fewer than 7 credit hours) from the electives below:			7-9
CHEM 500	Advanced Analytical Chemistry	3	
CHEM 505	Spectroscopic Methods I	3	
CHEM 506	Sampling and Sample Preparation	3	
CHEM 509	Physical Methods of Characterization	3	
CHEM 512	Spectroscopic Methods II	2	
CHEM 513	Statistics for Analytical Chemists	3	
CHEM 515	Gas Chromatography -- Theory and Practice	3	
CHEM 516	Liquid Chromatography -- Theory and Practice	3	
CHEM 542	Polymer Characterization and Analysis	3	
CHEM 543	Analytical Chemistry in Pharmaceutical Laboratories	2	
CHEM 544	Colloids and Colloid Analysis	2	
Total Credit Hours			9-11

Certificate in Analytical Spectroscopy

Curriculum

Required courses			(9-11)
CHEM 505	Spectroscopic Methods I		3
CHEM 512	Spectroscopic Methods II		2
Select a minimum of two courses from the following electives:			4-6
CHEM 500	Advanced Analytical Chemistry	3	
CHEM 506	Sampling and Sample Preparation	3	
CHEM 508	Analytical Methods Development	2	
CHEM 509	Physical Methods of Characterization	3	
CHEM 513	Statistics for Analytical Chemists	3	
CHEM 515	Gas Chromatography -- Theory and Practice	3	
CHEM 516	Liquid Chromatography -- Theory and Practice	3	
CHEM 542	Polymer Characterization and Analysis	3	
CHEM 543	Analytical Chemistry in Pharmaceutical Laboratories	2	
CHEM 544	Colloids and Colloid Analysis	2	
Total Credit Hours			9-11

Certificate in Chromatography

Curriculum

Required courses			(10-12)
CHEM 515	Gas Chromatography -- Theory and Practice		3
CHEM 516	Liquid Chromatography -- Theory and Practice		3
Select a minimum of two courses from the following electives:			4-6
CHEM 500	Advanced Analytical Chemistry	3	
CHEM 505	Spectroscopic Methods I	3	
CHEM 506	Sampling and Sample Preparation	3	
CHEM 508	Analytical Methods Development	2	
CHEM 509	Physical Methods of Characterization	3	
CHEM 512	Spectroscopic Methods II	2	
CHEM 513	Statistics for Analytical Chemists	3	
CHEM 542	Polymer Characterization and Analysis	3	
CHEM 543	Analytical Chemistry in Pharmaceutical Laboratories	2	
CHEM 544	Colloids and Colloid Analysis	2	
Total Credit Hours			10-12

Certificate in Materials Chemistry

The following three graduate certificate programs are available:

- Synthesis and Characterization of Inorganic Materials
- Synthesis and Characterization of Organic Materials
- Characterization of Inorganic and Organic Materials

To earn a certificate in materials chemistry, a minimum of 12 credit hours of coursework from the following two groups of courses is required. At least one course must be chosen from Group A and at least one course must be chosen from Group B. The remaining credit hours may be chosen from either group, depending upon the certificate program. Each of these courses, if completed with a "B" or higher, may be later applied toward the Master of Chemistry in Materials Chemistry degree if a student applies and is accepted to the degree program.

Group A

CHEM 505	Spectroscopic Methods I	3
CHEM 509	Physical Methods of Characterization	3
CHEM 512	Spectroscopic Methods II	2
CHEM 542	Polymer Characterization and Analysis	3

Group B

CHEM 521	Structural Inorganic and Materials Chemistry	3
CHEM 522	Efficient Chemical and Materials Synthesis	3
CHEM 530	Organic Reaction Mechanisms	3
CHEM 531	Tactics in Organic Synthesis	3
CHEM 535	Polymer Synthesis	3

Certificate in Regulatory Science

Curriculum

Required courses		(10-12)
CHEM 518	Understanding the International Conference on Harmonization Guidelines	3
CHEM 519	Good Manufacturing Practices	3
Select 4-6 credit hours from the designated regulatory science electives		4-6
Total Credit Hours		10-12

Regulatory Science Electives

BIOL 410	Medical Microbiology	3
BIOL 445	Cell Biology	3
BIOL 503	Virology	3
BIOL 504	Biochemistry	3
BIOL 512	Advanced Biochemistry	3
BIOL 514	Toxicology	3
BIOL 515	Molecular Biology	3
BIOL 526	Developmental Biology	3
BIOL 527	Immunology and Immunochemistry	3
BIOL 530	Human Physiology	3
BIOL 542	Advanced Microbiology	3
BIOL 544	Molecular Biology of Cells	3
BIOL 545	Advanced Cell Biology	3
BIOL 550	Bioinformatics	3
BIOL 555	Macromolecular Structure	3
BIOL 562	Current Topics in Functional Genomics	3
CHEM 500	Advanced Analytical Chemistry	3
CHEM 505	Spectroscopic Methods I	3
CHEM 506	Sampling and Sample Preparation	3
CHEM 508	Analytical Methods Development	2
CHEM 509	Physical Methods of Characterization	3
CHEM 512	Spectroscopic Methods II	2
CHEM 515	Gas Chromatography -- Theory and Practice	3
CHEM 516	Liquid Chromatography -- Theory and Practice	3
CHEM 524	Synthesis and Intellectual Property Management	2
CHEM 542	Polymer Characterization and Analysis	3
CHEM 543	Analytical Chemistry in Pharmaceutical Laboratories	2
CHEM 544	Colloids and Colloid Analysis	2

Computer Science

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Chair
Eunice Santos

Associate Chair
Bogdan Korel

Faculty with Research Interests
For more information regarding faculty visit the Department of Computer Science website.

The study of computer science is the inquiry into the nature of computation and its use in solving problems in an information-based society. Computer science is an evolving discipline, but it has a well-defined core of knowledge and a set of characteristic methodologies. The methods and skills required of the computer scientist include formalization and abstraction, algorithm design, programming, organization of unstructured knowledge, modeling, language development, and software system architecture and design. The graduate program in computer science at Illinois Institute of Technology stresses high achievement in both fundamental knowledge and practical problem solving. It offers the student a solid background in the core areas and exposure to cutting-edge computer technologies.

Research Facilities

The department has research computing facilities that include several state of the at computer clusters and workstations. The equipment includes a large-scale Sun “ComputerFarm” consisting of 172 processors and 562 cores connected via a Linux-based IBM cluster, an Opteron cluster from Microsoft, and a Cray XD1 Connected Management. An advanced technology Access Grid node has been installed by the department, which allows researchers, teachers, and students at different locations worldwide to interact via a network multimedia environment. Research in Data-Intensive Distributed Systems is facilitated by a 12-node cluster with 118 cores, 382 GB RAM, and 32TB of hard disk space. Research labs in the department have advanced computer work-stations with multicore servers.

Research Areas

Algorithms, artificial intelligence, bioinformatics, cloud computing, computational science, computer architecture, computer graphics, computer networking and telecommunications, computer vision, cyber security, data structures, database systems, distributed and parallel processing, I/O systems, image processing, information retrieval, machine learning, natural language processing, scientific computing, social computing, software engineering, and system software.

Accelerated Programs

The department offers accelerated courses for credit in several areas of computer science. These courses go beyond traditional core topics and are designed for working professionals who are interested in keeping abreast of rapidly changing technologies. Accelerated courses provide an opportunity for degree-seeking students at the university to complete M.S. and M.C.S. degree requirements in a shorter time period. If taken by non-degree students, these courses can be applied towards requirements for an M.S. or M.C.S. degree at the university.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0
Cumulative master of science GPA minimum (for Ph.D. applicants): 3.5/4.0

GRE minimum score for tests taken on or after Oct.1, 2011:

MAS

292 (quantitative + verbal); 2.5 analytical writing

M.S.

298 (quantitative + verbal); 3.0 analytical writing

Ph.D.

310 (quantitative + verbal); 4.0 analytical writing

TOEFL score (international students from non-English speaking countries): 70

PTE score (international students from non-English speaking countries): 47

IELTS score (international students from non-English speaking countries): 5.5

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. Applicants to master's degree programs in computer science should hold a bachelor's degree in computer science with a minimum overall GPA of 3.0/4.0 or its equivalent. For international students from non-English speaking countries, a minimum TOEFL score of 70 is required. All applicants must submit scores from the GRE general test. (The GRE requirement is waived for applicants to the Master of Computer Science program who hold bachelor's degrees from accredited U.S. institutions with a minimum cumulative GPA of 3.0/4.0.) Applicants with bachelor's degrees in other disciplines can be admitted to Master of Science or Master of Computer Science programs. However, students whose training does not include the equivalent of CS 201 (Accelerated Introduction to Computer Science), CS 330 (Discrete Structures), CS 331 (Data Structures and Algorithms), CS 350 (Computer Organization and Assembly Language Programming) and CS 351 (Systems Programming) will be required to complete all of the courses in which a deficiency exists. Some students may be able to complete their deficiencies with the following six-credit hour sequence with grades of "B" or better.:

CS 401	Introduction to Advanced Studies I	3
CS 402	Introduction to Advanced Studies II	3

In addition, students who have not had at least one course in calculus will be required to take a calculus course.

Applicants to the Ph.D. program should hold an M.S. degree in computer science with a minimum GPA of 3.0/4.0 for their bachelor's degree and 3.5/4.0 for their M.S. degree, or a minimum GPA of 3.5/4.0 for their bachelor's degree if they apply without a M.S. degree. For non-English speaking applicants without a U.S. degree, a minimum TOEFL score of 70 is required.

Degrees Offered

- Master of Computer Science (p. 267)
- Master of Computer Science with specialization in: (p. 268)

  Business
  Computational Intelligence
  Cyber-Physical Systems
  Data Analytics
  Database Systems
  Distributed and Cloud Computing
  Education
  Finance
  Information Security and Assurance
  Networking and Communications
  Software Engineering

- Master of Science in Computer Science (p. 277)
- Doctor of Philosophy in Computer Science (p. 280)

Dual Degree Program

- Master of Science in Computer Science/Master of Chemical Engineering (with Chemical and Biological Engineering) (p. 279)

Joint Degree Programs

- Master of Data Science (with Applied Mathematics) (p. 273)
- Master of Telecommunications and Software Engineering (with Electrical and Computer Engineering) (p. 274)
- Master of Science in Computational Decision Sciences and Operations Research (with Applied Mathematics) (p. 276)

Certificate Programs

Course Descriptions

CS 511
Topics in Computer Graphics
Covers advanced topics in computer graphics. The exact course contents may change based on recent advances in the area and the instructor teaching it. Possible topics include: Geometric modeling, Subdivision surfaces, Procedural modeling, Warping and morphing, Model reconstruction, Image based rendering, Lighting and appearance, Texturing, Natural phenomena, Nonphotorealistic rendering Particle systems, Character animation, Physically based modeling and animation.
Prerequisite(s): [(CS 411)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 512
Computer Vision
Introduction to fundamental topics in computer vision and the application of statistical estimation techniques to this area. Intended to give the student a good basis for work in this important field. Topics include: Feature extraction, Probabilistic modeling, Camera calibration, Epipolar geometry, Statistical estimation, Model reconstruction, Statistical filtering, Motion estimation, Recognition, Shape from single image cues.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 513
Geospatial Vision and Visualization
Geospatial information has become ubiquitous in everyday life as evidenced by on-line mapping services such as NOKIA Here Map, Microsoft Bing Map, the "place" features on social network websites such as Facebook, and navigation apps on smart phones. Behind the scenes is digital map content engineering that enables all types of location-based services. Course material will be drawn from the instructor's research and development experience at NOKIA Location and Commerce (formerly NAVTEQ), the Chicago-based leading global provider of digital map, traffic, and location data. This course will provide a comprehensive treatment of computer vision, image processing and visualization techniques in the context of digital mapping, global positioning and sensing, next generation map making, and three-dimensional map content creations. Real world problems and data and on-site industry visits will comprise part of the course curriculum.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 520
Data Integration, Warehousing, and Provenance
This course introduces the basic concepts of data integration, data warehousing, and provenance. We will learn how to resolve structural heterogeneity through schema matching and mapping. The course introduces techniques for querying several heterogeneous datasources at once (data integration) and translating data between databases with different data representations (data exchange). Furthermore, we will cover the data-warehouse paradigm including the Extract-Transform-Load (ETL) process, the data cube model and its relational representations (such as snowflake and star schema), and efficient processing of analytical queries. This will be contrasted with Big Data analytics approaches that (besides other differences) significantly reduce the upfront cost of analytics. When feeding data through complex processing pipelines such as data exchange transformations or ETL workflows, it is easy to lose track of the origin of data. Therefore, in the last part of the course we cover techniques for representing and keeping track of the origin and creation process of data (its provenance). The course emphasizespractical skills through a series of homework assignments that help students develop a strong background in data integration systems and techniques. At the same time, it also addresses the underlying formalisms. For example, we will discuss the logic based languages used for schema mapping and the dimensional data model as well as their practical application (e.g., developing an ETL workflow with rapid miner and creating a mapping between two example schemata). The literature reviews will familiarize students with data integration and provenance research.
Prerequisite(s): [(CS 425)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 521
Object-Oriented Analysis and Design
This course describes a methodology that covers a wide range of software engineering techniques used in system analysis, modeling and design. These techniques integrate well with software process management techniques and provide a framework for software engineers to collaborate in the design and development process. The methodology features the integration of concepts, including software reusability, frame works, design patterns, software architecture, software component design, use-case analysis, event-flow analysis, event-message analysis, behavioral-life cycle analysis, feature, multiple-product, risk and rule analysis, and automatic code generation. (Credit will not be given for CS 521 if CS751 is taken)
Prerequisite(s): [(CS 445) OR (CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 522
Advanced Data Mining
Continued exploration of data mining algorithms. More sophisticated algorithms such as support vector machines will be studied in detail. Students will continuously study new contributions to the field. A large project will be required that encourages students to push the limits of existing data mining techniques.
Prerequisite(s): [(CS 422)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 525
Advanced Database Organization
Comprehensive coverage of the problems involved in database system implementation and an in-depth examination of contemporary structures and techniques used in modern database management systems. Teaches advanced skills appropriate for DBMS architects and developers , database specialist, and the designers and developers of client/server and distributed systems. Focus is on transaction management, database structures and distributed processing.
Prerequisite(s): [(CS 425)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 529
Information Retrieval
The course covers the advanced topics in Information Retrieval. The topics such as Summarization, cross-lingual, Meta-Search, Question Answering, Parallel and distributed IR systems are discussed. The students get involved in research ideas, and get involved in individual and group projects.
Prerequisite(s): [(CS 429)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 530
Theory of Computation
Computability topics such as Turing machines, nondeterministic machines, undecidability, and reducibility. Computational complexity topics such as time complexity, NP-completeness and intractability, time and space hierarchy theorems. Introduces the complexity classes P, NP, NL, L, PSPACE, NC, RNC, BPP and their complete problems.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 531
Topics in Automata Theory
Topics selected from mathematical systems and automata theory, decision problems, realization and minimization, algebraic decomposition theory and machines in a category.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 533
Computational Geometry
This course covers fundamental algorithms and data structures for convex hulls, Voronoi diagrams, Delauney triangulation, Euclidean spanning trees, point location, and range searching. Also included are lower bounds and discrepancy theory. Optimization in geometry will be covered. This includes fixed dimensional linear programming and shortest paths. Graphic data structures such as BSP trees will be covered.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 535
Design and Analysis of Algorithms
Design of efficient algorithms for a variety of problems, with mathematical proof of correctness and analysis of time and space requirements. Topics include lower bounds for sorting and medians, amortized analysis of advanced data structures, graph algorithms (strongly connected components, shortest paths, minimum spanning trees, maximum flows and bipartite matching) and NP-Completeness.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 536
Science of Programming
Formal specification of how programs execute operational semantics , how mathematical functions programs compute denotational semantics , and how to use logic to characterize properties and invariants of the program execution (axiomatic semantics).
Prerequisite(s): [(CS 331) OR (CS 401)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 537
Software Metrics
Theoretical foundations for software metrics. Data collection. Experimental design and analysis. Software metric validation. Measuring the software development and maintenance process. Measuring software systems. Support for metrics. Statistical tools. Setting up a measurement program. Application of software measurement.
Prerequisite(s): [(CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 538
Combinatorial Optimization
Linear programs and their properties. Efficient algorithms for linear programming. Network flows, minimum cost flows, maximum matching, weighted matching, matroids.Prerequisite:CS 430 and a linear algebra course.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 539
Game Theory: Algorithms and Applications
This course focuses on computational issues in the theory of games, economics, and network design. Interest in the algorithmic aspects of games is motivated by the computational issues of fundamental aspects of games and economic theory, e.g. Nash equilibrium and market equilibrium. Computing and approximating Nash equilibrium will be studied. Of considerable interest to the computer science community are problems that arise from the Internet and computer networks and are similar to issues that arise in traditional transport networks, e.g. Wardrop equilibrium.
Prerequisite(s): [(CS 430) OR (CS 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 540
Syntactic Analysis of Programming Languages
Formal definition of syntax with emphasis on context-free languages. Elementary techniques for scanning and parsing programming languages. Symbol table management. Semantic routines and code generation. The class will write a simple translator.
Prerequisite(s): [(CS 440)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 541
Topics in Compiler Construction
Advanced topics in compiler construction, including incremental and interactive compiling, error correction, code optimization, models of code generators, etc. The objective of the course is to provide an in-depth coverage of compiler optimization techniques, including both classical optimization and areas of current interest in compiler research.
Prerequisite(s): [(CS 440)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 542
Computer Networks I: Fundamentals
This course focuses on the engineering and analysis of network protocols and architecture in terms of the Internet. Topics include content distribution, peer-to-peer networking, congestion control, unicast and multicast routing, router design, mobility, multimedia networking quality of service, security and policy-based networking.
Prerequisite(s): [(CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 544
Computer Networks II: Network Services
Qualitative and quantitative analysis of networks. A combination of analytical and experimental analysis techniques will be used to study topics such as protocol delay, end-to-end network response time, intranet models, Internet traffic models, web services availability, and network management.
Prerequisite(s): [(CS 542) OR (ECE 545)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 545
Distributed Computing Landscape
Introduction to the theory of concurrent programming languages. Topics include formal models of concurrent computation such as process algebras, nets, and actors; high-level concurrent programming languages and their operational semantics; and methods for reasoning about correctness and complexity of concurrent programs.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 546
Parallel and Distributed Processing
This course covers general issues of parallel and distributed processing from a user's point of view which includes system architectures, programming, performance evaluation, applications, and the influence of communication and parallelism on algorithm design.
Prerequisite(s): [(CS 430 and CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 547
Wireless Networking
This course introduces cellular/PCS systems, short-range mobile wireless systems, fixed wireless systems, satellites, and ad hoc wireless systems. It explains in detail the underlying technology as well as regulations, politics, and business of these wireless communications systems. It looks beyond the hype, examining just what is and is not possible with present-day and future wireless systems. As an advanced graduate course, it will combine extensive reading and in-class discussion of the research literature with in-depth independent research projects of students' own choosing.
Prerequisite(s): [(CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 548
Broadband Networks
The course studies the architectures, interfaces, protocols, technologies, products and services for broadband (high-speed) multimedia networks. The key principles of the protocols and technologies used for representative network elements and types of broadband network are studied. Specifically, cable modems, Digital Subscriber Lines, Power Lines, wireless 802.16 (WiMax), and broadband cellular Internet are covered for broadband access; for broadband Local Area Networks (LANs), Gigabit Ethernet, Virtual LANs and wireless LANs (802.11 WiFi and Bluetooth) are discussed; for broadband Wide Area Networks (WANs) the topics covered include optical networks (SONET/SDH,DWDM, optical network nodes, optical network nodes, optical switching technologies), frame-relay, ATM, wire-speed routers, IP switching, and MPLS. Also, quality of service issues in broadband networks and a view of the convergence of technologies in broadband networks are covered.
Prerequisite(s): [(CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 549
Cryptography and Network Security
This course provides an introduction to the theory and practice of cryptography and network security. The course covers conventional encryption such as classical encryption techniques, modern encryption techniques and encryption algorithms. Students are introduced to the basic number theory, which is used as the foundation for public-key encryption. The public-key cryptography such as encryption methods and digital signatures is covered. Message authentication and hash functions are also discussed. Students will learn techniques of key management, secret sharing and conducting interactive proofs. In addition, the practical network and security protocols are discussed.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 550
Advanced Operating Systems
Advanced operating system design concepts such as interprocess communication, distributed processing, replication and consistency, fault tolerance, synchronization, file systems. Study of systems highlighting these concepts.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 551
Operating System Design and Implementation
This course covers in detail the design and implementation of processes, interprocess communication, semaphores, monitors, message passing, scheduling algorithm, input/output, device drivers, memory management, file system design, security and protection mechanisms. The hardware-software interface and the user process-system call-kernel interface are examined in detail. Students modify and extend a multiuser operating system.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 552
Distributed Real-Time Systems
With the advancement of computer hardware, embedded devices, and network technology, real-time applications have become pervasive, ranging from smart automobiles to automated traffic control. Different from general-purpose applications, correct executions of real-time applications depend on both functional correctness and temporal correctness. This course is to study the fundamentals of distributed real-time computing with the focus on its temporal aspects.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 553
Cloud Computing
This course is a tour through various topics and technologies related to cloud computing. Students will explore solutions and learn design principles for building large network-based systems to support both compute-intensive and data-intensive applications across geographically distributed infrastructure. Topics include resource management, programming models, application models, system characterizations, and implementations. Discussions will often be grounded in the context of deployed cloud computing systems such as Amazon EC2 and S3, Microsoft Azure, Google AppEngine, Eucalyptus, Nimbus, OpenStack, Google's MapReduce, Yahoo's Hadoop, Microsoft's Dryad, Sphere/Sector, and many other systems. The course involves lectures, outside invited speakers, discussions of research papers, programming assignments, and a major project (including both a written report and an oral presentation).
Prerequisite(s): [(CS 450) OR (CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 554
Data-Intensive Computing
This course is a tour through various research topics in distributed data-intensive computing, covering topics in cluster computing, grid computing, supercomputing, and cloud computing. The course will explore solutions and learn design principles for building large network-based computational systems to support data-intensive computing. This course is geared for junior/senior-level undergraduates and graduate students in computer science.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 555
Analytic Models and Simulation of Computer Systems
Analytic and simulation techniques for the performance analysis of computer architecture, operating systems and communication networks. Rigorous development of queuing models. Study of simulation languages and models.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 556
Cyber-Physical Systems: Languages and Systems
Different from general-purpose and traditional computer applications, cyber-physical systems have both continuous and discrete components, hence requiring new methodologies to integrate traditional continuous control theory/systems with traditional discrete software systems. The focus of this course is to discuss and understand the challenges in emerging cyber-physical systems and to explore possible solutions from the perspectives of systems specification, system modeling, programming languages, systems designs, and software engineering. This course will focus on the languages and systems aspects of cyber-physical systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 557
Cyber-Physical Systems: Networking and Algorithms
The goal of the course is to provide students with the necessary foundations to apply wireless sensor networking, scheduling theory, and algorithms in the field of computer science. The focus is to discuss and understand the challenges in emerging cyber-physical systems, open distributed real-time systems, and wireless sensor networks. The course will examine different perspectives of wireless networks such as various MAC protocols, routing protocols, scheduling protocols, localization, clock synchronization, data aggregation and data fusion, compressive and cooperative sensing, security, fault detection and diagnosis, online program, and networked control systems. The course will also examine the interaction of different systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 558
Advanced Computer Security
This course will teach various modern topics in network and computer security. It will provide a thorough grounding in cyber-security for students who are interested in conducting research on security and networking and for students who are more broadly interested in real-world security issues and techniques. Students will undertake a semester-long research project with the goal of technical publications. Lecture topics will include, but not limited to: (1) Unwanted traffic, such as denial of service (DoS), and spam; (2) Malware, such as botnet, worm, and virus; (3) Network configuration and defense, such as firewall, access control, and intrusion detection systems; (4) Cyber physical system security, such as critical infrastructure protection (e.g., smart grid); and (5) Hot topics, such as software-defined networking (SDN), network verification, data center and enterprise network security, web security and more.
Prerequisite(s): [(CS 450) OR (CS 455) OR (CS 458)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 560
Computer Science in the Classroom
Emphasis on how to organize a selected computer science course. Discussion of what to teach, the problems typically encountered in teaching, and how to best organize the concepts in a computer science course.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 561
The Computer and Curriculum Content
Presentation techniques from white board to web-based instructional units using currently available software. Emphasis on incorporating the computer as a teaching tool in the presentation of class material. Single Concept Learning Modules (SCLM) are developed.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 565
Computer Assisted Instruction
Hardware and software for the effective use of the computer in an educational environment, CAI (Computer-Assisted/Aided Instruction) being one of the major areas of investigation .
Prerequisite(s): [(CS 560) OR (CS 561)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 566
Practicum in the Application of Computers to Education
Provides supervised experience in the development of computer-based teaching units. Evaluation of different theoretical and/or technical approaches to the use of computer in the classroom.
Prerequisite(s): [(CS 560 and CS 561)]
Lecture: 1 **Lab:** 4 **Credits:** 3

CS 570
Advanced Computer Architecture
Computer system design and architecture such as pipelining and instruction-level parallelism, memory-hierarchy system, interconnection networks, multicore and multiprocessors, and storage architecture. Selected study on current experimental computer systems.
Prerequisite(s): [(CS 450 and CS 470)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 572
Advanced Topics in Computer Architecture
Current problems in computer architecture.
Prerequisite(s): [(CS 570)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 579
Online Social Network Analysis
This course will explore the latest algorithms for analyzing online social networks, considering both their structure and content. Fundamentals of social graph theory will be covered including distance, search, influence, community discovery, diffusion, and graph dynamics. Fundamentals of text analysis will also be covered with an emphasis on the type of text used in online social networks and common applications. Topics include sentiment classification, information extraction, clustering, and topic modeling. Emphasis will be placed on the application of this technology to areas such as public health, crisis response, politics, and marketing.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 580
Topics in Machine Learning
This course covers advanced topics in machine learning. The exact course contents may change based on recent advances in the area and the instructor teaching it. Possible topics include active learning, reinforcement learning, online learning, non-parametric learning, inductive learning, statistical relational learning, dimensionality reduction, ensemble methods, transfer learning, outlier detection, specific application areas of machine learning, and other relevant and/or emerging topics.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 581
Topics in Artificial Intelligence
Covers various advanced topics in AI, including both theory and practice. Content may vary by instructor. Possible topics include: Planning: STRIPs planning; Partial-order planning; Situation calculus; Theorem proving; GraphPlan/SatPlan; Transformational planning; Simulated annealing; Motion planning; Case-based reasoning; Multi-agent coordination; Negotiation planning; Representation and Reasoning: Logical representation; Frame problem; Probabilistic reasoning; Bayesian networks; Game Playing: Minimax search; Evaluation functions; Learning evaluation functions; Markov Decision Processes; Reinforcement learning for games; Developing AI agents; Multi-agent planning.
Prerequisite(s): [(CS 480)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 582
Computational Robotics
Covers basic algorithms and techniques used in Computational Robotics, to give the student a good basis for work in this highly relevant field. Topics include: Locomotion, Non-visual sensors and algorithms, Uncertainty modeling, data fusion, State space models, Kalman filtering, Visual sensor, Sampling theory, Image features, Depth reconstruction, Multiple view geometry, Ego-motion, Active vision, Reasoning, Spatial decomposition, Geometric representations, Topological representations, Path planning, Spatial uncertainty, Active control, Pose maintenance, Dead reckoning, Correlation-based localization, Sensorial maps, Task planning and task interference, Multi-agent coordination.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 583
Probabilistic Graphical Models
This course will cover probabilistic graphical models -- powerful and interpretable models for reasoning under uncertainty. The generic families of models such as directed, undirected, and factor graphs as well as specific representations such as hidden Markov models and conditional random fields will be discussed. The discussions will include both the theoretical aspects of representation, learning, and inference, and their applications in many interesting fields such as computer vision, natural language processing, computational biology, and medical diagnosis.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 584
Machine Learning
Introduce fundamental problems in machine learning. Provide understanding of techniques, mathematical concepts, and algorithms used in machine learning. Provide understanding of the limitations of various machine learning algorithms and the way to evaluate performance of learning algorithms. Topics include introduction, regression, kernel methods, generative learning, discriminative learning, neural networks, support vector machines, graphical models, unsupervised learning, and dimensionality reduction.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 585
Natural Language Processing
An introduction to the problems of computing with human languages. Parsing. Semantic representations. Text generation. Lexicography. Discourse. Sublanguage studies. Applications to CAI, database interfaces and information retrieval.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 586
Software Systems Architectures
This course covers the state-of-the-art in architectural design of complex software systems. The course considers commonly-used software system architectures, techniques for designing and implementing these architectures, models and notations for characterizing and reasoning about architectures, and case studies of actual software system architectures.
Prerequisite(s): [(CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 587
Software Project Management
Concepts of software product and process quality. Role of TQM in software project management. Use of metrics, feasibility studies, cost and effort estimates. Discussion of project planning and scheduling. The project team and leadership issues. The Capability Maturity Model: basic tenets and application of process evaluation.
Prerequisite(s): [(CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 588
Advanced Software Engineering Development
Software development process improvement is a major objective of this course. This is achieved through a series of individual programming and process projects. Students learn to plan their projects, apply measurements, estimate size, schedule tasks, and classify defects in order to improve the quality of both their development process and their software products.
Prerequisite(s): [(CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 589
Software Testing and Analysis
Concepts and techniques for testing and analysis of software. Software testing at the unit, subsystem, and system levels. Specification-based testing. Code-based testing. Model-based testing. Methods for test generation and validation. Static and dynamic analysis. Formal methods and verification. Reliability analysis.
Prerequisite(s): [(CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 590
Seminar in Computer Science
Investigation and discussion by faculty and students concentrated on some topic of current interest. May be taken more than once. Prerequisite: Instructor permission required.
Lecture: 0 **Lab:** 0 **Credits:** 3

CS 591
Research and Thesis of Masters Degree
Instructor permission required.
Credit: Variable

CS 594
Research Problems
Instructor permission required.
Credit: Variable

CS 595
Topics in Computer Science
This course will treat a specific topic, varying from semester to semester, in which there is a particular student or staff interest. May be taken more than once.
Credit: Variable

CS 597
Reading and Special Problems
May be taken more than once. (Credit: Variable) Instructor permission required.
Credit: Variable

CS 612
Topics in Computer Vision
Covers advanced topics in computer vision to enhance knowledge of students interested in this highly important area. The topics in this course may change between semesters depending on the instructor teaching the course and the current state of the art in this area. Possible topics include: Image based modeling and rendering, Multiple view geometry, Auto-calibration, Object recognition, Motion analysis, Tracking, Perceptual user interfaces, Face and gesture recognition, Active vision.
Prerequisite(s): [(CS 512)]
Lecture: 0 **Lab:** 0 **Credits:** 3

CS 630
Advanced Topics in Algorithms
Theoretical analysis of various types of algorithms. Topics vary, and may include approximation, quantum, on-line, distributed, randomized, and parallel algorithms. Requires CS 430. Instructor permission required.
Prerequisite(s): [(CS 430)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 642
Advanced Topics in Networking
Introduction to advanced networking research. A particular focus area will be considered, keeping current with advances in computer networking. Quantitative methods will be emphasized.
Prerequisite(s): [(CS 542)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 681
Topics in Computational Linguistics
CS 585 Covers various topics in linguistics as they may be applied to various computational problems in AI, NLP, or IR. The topics in this course may change between semesters depending on the instructor teaching the course and the current state of the art in this area. Possible topics include: Systemic Functional Linguistics, Clausal structure, Group structure, Complex structure, Cognitive Linguistics, Process semantics.
Prerequisite(s): [(CS 585)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 689
Advanced Topics in Software Engineering
Course content is variable and reflects the current trends in software engineering. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

CS 691
Research and Thesis Ph.D.
Instructor permission required.
Credit: Variable

CS 695
Doctoral Seminar
Doctoral seminar.
Lecture: 0 **Lab:** 0 **Credits:** 1

CS 750
Computer Aided Software Engineering
This course presents the state-of-the-art of computer-aided software engineering technologies. CASE encompasses a collection of automated tools and methods that provide automated support to the software specification, design, development, testing, maintenance, and management of large and complex software systems. Students will develop working understanding of CASE methodologies and tools.
Prerequisite(s): [(CS 487)]
Lecture: 2 **Lab:** 0 **Credits:** 2

CS 763
Automated Software Testing
This course will examine both the state-of-the-art and the state-of-practice in automated software testing on a system level and an unit level. Relevant issues include theoretical foundations of automated testing, automation tools and techniques, empirical studies and industrial experience. Key topics include, but are not limited to: Fundamentals of automated software testing, automated test design, modeling and generation, automated test execution, automated test management, automated test metrics, automated tools, automated feature and regression testing Environments to support cost-effective automated software testing, discussions on the barriers to industrial use of automated testing.
Prerequisite(s): [(CS 487)]
Lecture: 2 **Lab:** 0 **Credits:** 2

CSP 527
Client-Server Applications Development
Through hands-on experience in developing a client-server database project and developing and managing a client-server Internet project, this course teaches advanced skills for effective design and implementation of client-server applications. Students will examine the architectural and functionality decisions, technologies, configurations, languages, and techniques associated with client-server systems. Active/passive client-server technologies, as well as public, enterprise-wide, and inter-enterprise approaches to decision and operation support are discussed and implemented.
Prerequisite(s): [(CS 425)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 541
Internet Technologies
This course focuses on the technologies and protocols used by Internet WAN's and LAN's. The fundamental architecture, organization, and routing principles of the Internet are described. Part of the course will focus on emerging Internet technologies.
Prerequisite(s): [(CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 542
Internet Design and Analysis
This course examines the principles for network design. The design process is studied from requirements gathering to deployment. The student will gain experience in estimating application load, network sizing, component choice, and protocol choice. Internetworking between popular components and protocols will be studied. Analytical and simulation techniques are described and used to design several local- and wide-area networks.
Prerequisite(s): [(CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 543
Multimedia Networking
This course covers the architectures, protocols, and design issues for multimedia networks. Topics covered include coding, compression, streaming, synchronization, QoS, and adaptation. Current tools for multimedia networking will be surveyed. Issues with multimedia application development will be explored. Students will design and develop multimedia applications.
Prerequisite(s): [(CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 544
System and Network Security
This course will present an in-depth examination of topics in data and network security such as: Access control, authentication, security assessment, network and data security tools, and security policies. A significant hands-on component includes network incidents to detect and fix.
Prerequisite(s): [(CS 430 and CS 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 545
Wireless Networking Technologies and Applications
This course will present the foundation of wireless technologies and examine state-of-the-art wireless systems, services, network technologies, and security.
Prerequisite(s): [(CS 542)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 550
Internet Programming
This course discusses current fundamental concepts and development techniques for distributed applications. Topics covered include multithreaded programs, sockets, message-passing systems, remote method invocation and procedure calls, peer-to-peer networks, and underlying technologies for internet applications.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 551
Advanced UNIX Programming
This course provides a hand-on introduction to UNIX programming topics such as standard application programmer interfaces, concurrent programming, UNIX processes and threads, shell programming, UNIX interprocess communications, client-server designs, and application portability.
Prerequisite(s): [(CS 450)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 570
Data Science Seminar
This required seminar course surveys current applications of data science, bringing in lecturers from industry and academia to discuss real-world problems and how they are addressed within a data analytic framework. Students are required to attend all lectures and to give a short presentation or paper on one of the topics at the end of the semester. Permission is required from the instructor or department.
Lecture: 0 **Lab:** 0 **Credits:** 0

CSP 571
Data Preparation and Analysis
Surveys industrial and scientific applications of data analytics with case studies including exploration of ethical issues via case studies. Students will work with a variety of real world data sets and learn how to prepare data sets for analysis by cleaning and reformatting. We will also cover a variety of data exploration techniques including summary statistics and visualization methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 572
Data Science Practicum
Students will work in small groups to solve real-world data analysis problems for actual scientific or industrial clients. Innovation and clarity of presentation will be key elements of evaluation. Students will also have an option to fulfill course requirements through a data analytics internship with an industry partner.
Lecture: 0 **Lab:** 0 **Credits:** 6

CSP 581
Applied Artificial Intelligence Programming
To learn AI programming algorithms and techniques in common lisp. Time is split between common Lisp topics and discussions of implementation strategies for AI algorithms.
Prerequisite(s): [(CS 440)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 585
Object-Oriented Design Patterns
This course introduces the principles of design patterns for Object-Oriented software systems. A catalog of design patterns is shown, to illustrate the roles of patterns in designing and contracting complex software systems. The catalog of design patterns also provides a pragmatic reference to a well-engineered set of existing patterns currently in use. Also discussed is the impact of post-object oriented software development on design patterns.
Prerequisite(s): [(CS 445)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 586
Software Modeling Development with UML
Students will obtain a significant exposure to the UML technology. This will include exposure to modeling, model-driven development, executable models, and round-trip engineering.
Prerequisite(s): [(CS 445) OR (CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 587
Software Quality Management
Students will learn methods of software quality management. this will include exposure to software quality assurance, quality measures, and quality control. These quality management methods will be explained at the applications level.
Prerequisite(s): [(CS 487)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CSP 595
Topics in Computer Science Professional Master
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 511
Project Management
Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 522
Public Engagement for Scientists
This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

Master of Computer Science

This professional master's degree program consists of 30 credit hours of coursework in computer science. This program is designed for those without a prior degree in computer science, or those who are primarily interested in a (non-thesis) program preparing them for careers as working computer science professionals in business and industry. A full-time student enrolled in the program should be able to complete the requirements in 1 to 1.5 years. Specializations in business, computational intelligence, cyber-physical systems, data analytics, database systems, distributed and cloud computing, finance, information security and assurance, networking and communications, and software engineering are available.

Admission requirements include:

- Bachelor's degree from an accredited university with a minimum cumulative GPA of at least 3.0/4.0.
- Minimum GRE scores: 292 (combined quantitative and verbal) and 2.5 (analytical writing). The GRE requirement can be waived for students with a bachelor's degree from an accredited college or university in the United States with a cumulative GPA of at least 3.0/4.0.
- For applicants with degrees from schools where the primary language of instruction was not English, a minimum score of 70 on the internet-based TOEFL or 523 on the paper-based TOEFL, 47 on the PTE, or 5.5 on the IELTS exam is required for admission consideration.

Prerequisites include knowledge of a high level programming language at the level of CS 116 (Java or C/C++ programming is required). Students with insufficient background in computer science will be required to take CS 401 and CS 402 (Introduction to Advanced Studies I and II) and to earn at least a "B" in these courses. Students may also be required to take CS 201 and earn at least a "B" in the course. These prerequisite courses do not count toward the 30 credit hours requirement.

Curriculum

Minimum Degree Credits	30
Maximum 400-Level Credit	10
Maximum Accelerated Course Credit	6
Minimum 500-Level CS/CSP Credit	20

Programming Core Courses			(3)
Select a minimum of one course from the following:			3
CS 511	Topics in Computer Graphics	3	
CS 512	Computer Vision	3	
CS 525	Advanced Database Organization	3	
CS 540	Syntactic Analysis of Programming Languages	3	
CS 541	Topics in Compiler Construction	3	
CS 546	Parallel and Distributed Processing	3	
CS 551	Operating System Design and Implementation	3	
CS 553	Cloud Computing	3	
Systems Core Courses			(3)
Select a minimum of one course from the following:			3
CS 542	Computer Networks I: Fundamentals	3	
CS 544	Computer Networks II: Network Services	3	
CS 547	Wireless Networking	3	
CS 550	Advanced Operating Systems	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 570	Advanced Computer Architecture	3	
CS 586	Software Systems Architectures	3	
Theory Core Courses			(3)
Select a minimum of one course from the following:			3
CS 530	Theory of Computation	3	
CS 533	Computational Geometry	3	
CS 535	Design and Analysis of Algorithms	3	
CS 536	Science of Programming	3	
CS 538	Combinatorial Optimization	3	
CS 539	Game Theory: Algorithms and Applications	3	

Elective Courses	(21)
Select 21 credit hours [1]	21
Total Credit Hours	30

[1] Students may select electives in order to fulfill a desired specialization. See Specializations tab on this page for more details.

Master of Computer Science with Specialization in Business

33 credit hours

This program is designed to help computer science professionals extend and deepen their technical and practical knowledge of the field while introducing themselves to core topics in modern business practices. To complete the program, students must satisfy the general Master of Computer Science requirements, and the plan of study must include 24 credit hours of CS/CSP courses and three specialization courses from the Stuart School of Business.

Specialization Courses			(9)
Select a minimum of three courses from the following:			9
BUS 510	Building an Innovative and Sustainable Business	3	
BUS 550	Business Analytics for Competitive Advantage	3	
MBA 501	Accounting for Strategic Decision-Making	3	
MBA 502	Emerging Issues in the Global Business Environment	3	
MBA 504	Analytics for Decision Making	3	
MBA 506	Leadership in Knowledge-Intensive Organizations	3	
MBA 509	Financial Management in a Globalized World	3	
MBA 511	Creating, Communicating, and Delivering Customer Value	3	
Total Credit Hours			9

Note: Stuart School of Business tuition and fees apply to these courses. Applicants to the program are not required to take the GMAT.

Master of Computer Science with Specialization in Computational Intelligence

30 credit hours

This program is intended for students who are interested in ways in which computers may learn and adapt based on data so as to solve complex problems in various areas of computer science.

To qualify for the specialization in computational intelligence, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 480	Artificial Intelligence Planning and Control	3	
CS 512	Computer Vision	3	
CS 522	Advanced Data Mining	3	
CS 579	Online Social Network Analysis	3	
CS 583	Probabilistic Graphical Models	3	
CS 584	Machine Learning	3	
CS 585	Natural Language Processing	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Cyber-Physical Systems

30 credit hours

This program is intended for students who are interested in learning how to work with embedded controllers with integrated sensors and networking abilities and to utilize them for real-world applications.

To qualify for the specialization in cyber-physical systems, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 442	Mobile Applications Development	3	
CS 552	Distributed Real-Time Systems	3	
CS 553	Cloud Computing	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 556	Cyber-Physical Systems: Languages and Systems	3	
CS 557	Cyber-Physical Systems: Networking and Algorithms	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Data Analytics

30 credit hours

Intelligent analysis of large amounts of data is a crucial component in supporting business decisions. The Master of Science with Specialization in Data Analytics is intended for students interested in learning how to discover patterns in large amounts of data in information systems and how to use these to draw conclusions.

To qualify for the specialization in data analytics, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 442	Mobile Applications Development	3	
CS 520	Data Integration, Warehousing, and Provenance	3	
CS 522	Advanced Data Mining	3	
CS 554	Data-Intensive Computing	3	
CS 579	Online Social Network Analysis	3	
CS 583	Probabilistic Graphical Models	3	
CS 584	Machine Learning	3	
CS 585	Natural Language Processing	3	
CSP 571	Data Preparation and Analysis	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Database Systems

30 credit hours

This program is designed to provide in-depth knowledge of the principles of design and development of information systems. Students must satisfy Master of Computer Science requirements and are also required to select four specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 425	Database Organization	3	
CS 520	Data Integration, Warehousing, and Provenance	3	
CS 521	Object-Oriented Analysis and Design	3	
CS 522	Advanced Data Mining	3	
CS 525	Advanced Database Organization	3	
CS 529	Information Retrieval	3	
CS 553	Cloud Computing	3	
CS 554	Data-Intensive Computing	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Distributed and Cloud Computing

30 credit hours

The Master of Computer Science with a Specialization in Distributed and Cloud Computing is intended for students who are interested to learn about distributed systems and how they are applied to real world problems, as well as how emerging cloud computing technologies can be used to implement some of the world's most popular services and applications.

To qualify for the specialization in distributed and cloud computing, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 451	Introduction to Parallel and Distributed Computing	3	
CS 546	Parallel and Distributed Processing	3	
CS 550	Advanced Operating Systems	3	
CS 552	Distributed Real-Time Systems	3	
CS 553	Cloud Computing	3	
CS 554	Data-Intensive Computing	3	
CS 570	Advanced Computer Architecture	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Education

33 credit hours

The Master of Computer Science with a Specialization in Education is designed to enable computer science students to further their technical education while opening a career path toward teaching computer science.

Courses for the MCS/Education degree program are taken from the Department of Computer Science and the Department of Mathematics and Science Education (MSED). In addition to satisfying general Master of Computer Science degree requirements, the plan of study must include 24 credit hours of CS/CSP courses and the following three MSED courses, which are the first three required courses for a teaching certificate.

MSED Required Courses		(9)
MSED 300	Instructional Methods/Strategies I	3
MSED 500	Analysis of Classrooms II (Practicum and Seminar)	3
MSED 554	Middle and Secondary Level Science Curriculum	3
or MSED 555	Middle and Secondary Level Mathematics Curriculum	
Total Credit Hours		9

Master of Computer Science with Specialization in Finance

33 credit hours

The Master of Computer Science with a Specialization in Finance is designed to enable computer science students to further their technical education while opening a path toward a career in finance.

Courses for the MCS/Finance degree program are taken from the Department of Computer science and the Department of Finance in the Stuart School of Business. In addition to satisfying the general Master of Computer Science degree requirements, the plan of study must include 24 credit hours of CS/CSP courses and the following three MSF courses (9 credit hours).

Required Finance Courses		(9)
MSF 504	Valuation and Portfolio Management	3
MSF 505	Futures, Options, and OTC Derivatives	3
MSF 506	Financial Statement Analysis	3
Total Credit Hours		9

Master of Computer Science with Specialization in Information Security and Assurance

30 credit hours

Information security, privacy, and information assurance are of prime importance in modern computer systems where data can be accessed from nearly everywhere. The Master of Computer Science with a Specialization in Information Security and Assurance is intended for students interested in aspects of security and assurance in modern e-commerce applications.

To qualify for the specialization in information security and assurance, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses:

Specialization Courses			(12)
Select a minimum of four of the following courses:			12
CS 458	Introduction to Information Security	3	
CS 525	Advanced Database Organization	3	
CS 549	Cryptography and Network Security	3	
CS 558	Advanced Computer Security	3	
CSP 544	System and Network Security	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Networking and Communications

30 credit hours

This program is designed to provide an in-depth knowledge of the theories and practices in computer networking and telecommunications. Students must satisfy Master of Computer Science requirements and are also required to select four specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 455	Data Communications	3	
CS 542	Computer Networks I: Fundamentals	3	
CS 544	Computer Networks II: Network Services	3	
CS 547	Wireless Networking	3	
CS 548	Broadband Networks	3	
CS 549	Cryptography and Network Security	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 557	Cyber-Physical Systems: Networking and Algorithms	3	
Total Credit Hours			12

Master of Computer Science with Specialization in Software Engineering

30 credit hours

This program is designed to provide an in-depth knowledge of theory and practices in software engineering, including hands-on experience in software design, development and maintenance. Students must satisfy Master of Computer Science requirements and are also required to select four specialization courses.

Specialization Courses			(12)
Select a minimum of four courses from the following:			12
CS 487	Software Engineering I	3	
CS 521	Object-Oriented Analysis and Design	3	
CS 536	Science of Programming	3	
CS 537	Software Metrics	3	
CS 586	Software Systems Architectures	3	
CS 587	Software Project Management	3	
CS 589	Software Testing and Analysis	3	
Total Credit Hours			12

Master of Data Science

Collaborative program with the Department of Applied Mathematics

This professional master's degree program consists of 33 credit hours of coursework, including a practicum, in data science. The program is designed primarily for those with previous degrees or experience in computer science, statistics, mathematics, natural sciences, or business, who are interested in preparing for a career as a data science professional in business and industry. Full-time students may complete the program in one year, including one summer term.

Admission Requirements

Applicants should have a bachelor's degree from an accredited university with a minimum cumulative GPA of 3.0/4.0. A combined verbal and quantitative GRE examination score of at least 304 and an analytic writing score of at least 3.0 (for the post-October 2002 test) are required. The GRE requirement is waived for students with a bachelor's degree from an accredited college or university in the United States with a cumulative GPA of at least 3.0/4.0.

Prerequisites include knowledge of a high level programming language at the level of CS 201 (Java or C/C++programming is required), a data structures course at the level of CS 331, experience with database programming at the level of CS 425, linear algebra at the level of MATH 332, and probability and statistics at the level of MATH 474. Information on these courses is available in this catalog.

Students with an insufficient background in computer science and/or mathematics will be required to take the relevant prerequisite courses and earn at least a B grade in each. These prerequisite courses do not count toward the 33 credit hour requirement.

Curriculum

Coursework includes 18 credit hours of required core courses and 6 credit hours of CSP 572/MATH 572 Data Science Practicum. At least 9 credit hours must be taken of 500-level CS or CSP courses and 9 credit hours of 500-level MATH courses, not including the CSP 572/MATH 572 Data Science Practicum.

Up to 6 credit hours of 400-level undergraduate coursework may be used toward degree requirements.

Code	Title	Credit Hours
Data Science Core Courses		(18)
CS 525	Advanced Database Organization	3
or CS 554	Data-Intensive Computing	
MATH 563	Mathematical Statistics	3
or MATH 564	Applied Statistics	
SCI 511	Project Management	3
SCI 522	Public Engagement for Scientists	3
CS 584	Machine Learning	3
or MATH 569	Statistical Learning	
CSP 571	Data Preparation and Analysis	3
or MATH 571	Data Preparation and Analysis	
Data Science Capstone		(6)
CSP/MATH 572	Data Science Practicum	6
Data Science Electives		(9)
Select 9 credit hours of Data Science Electives		9
Total Credit Hours		33

Data Science Electives

Code	Title	Credit Hours
Computational Fundamentals		(27)
CS 425	Database Organization	3
CS 430	Introduction to Algorithms	3
CS 450	Operating Systems	3
CS 525	Advanced Database Organization	3
CS 535	Design and Analysis of Algorithms	3
CS 546	Parallel and Distributed Processing	3
CS 553	Cloud Computing	3

CS 554	Data-Intensive Computing	3
CS 589	Software Testing and Analysis	3
Computer Science Applications		(33)
CS 422	Data Mining	3
CS 512	Computer Vision	3
CS 513	Geospatial Vision and Visualization	3
CS 522	Advanced Data Mining	3
CS 529	Information Retrieval	3
CS 556	Cyber-Physical Systems: Languages and Systems	3
CS 557	Cyber-Physical Systems: Networking and Algorithms	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 584	Machine Learning	3
CS 585	Natural Language Processing	3
Mathematics, Probability, and Statistics		(33)
MATH 454	Graph Theory and Applications	3
MATH 486	Mathematical Modeling I	3
MATH 532	Linear Algebra	3
MATH 540	Probability	3
MATH 542	Stochastic Processes	3
MATH 553	Discrete Applied Mathematics I	3
MATH 554	Discrete Applied Mathematics II	3
MATH 565	Monte Carlo Methods in Finance	3
MATH 567	Advanced Design of Experiments	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Statistics	3
Mathematical and Scientific Computing		(15)
BIOL 550	Bioinformatics	3
MATH 577	Computational Mathematics I	3
MATH 578	Computational Mathematics II	3
MATH 590	Meshfree Methods	3
PHYS 440	Computational Physics	3

Master of Telecommunications and Software Engineering

Collaborative program with the Department of Electrical and Computer Engineering

The Master of Telecommunications and Software Engineering (M.T.S.E.) is a course-only degree program that prepares students for professional practice in telecommunications and information technologies. The program, jointly offered by the Department of Electrical and Computer Engineering (ECE) and the Department of Computer Science (CS), can be completed in one and one-half years of full-time study.

Admission Requirements

A person holding a B.S.E.E., B.S.CP.E. or B.S.C.S. degree has the necessary broad background to undertake the M.T.S.E. program. A student without adequate background in specific areas is required to demonstrate proficiency in prerequisite courses; an abbreviated list is given below.

Specific proficiency courses will be detailed for each student at the time of admission to the M.T.S.E. program. Proficiency in a course may be demonstrated by completing the course with a grade of "A" or "B", or by achieving a grade of "A" or "B" in a proficiency examination administered by the ECE or the CS departments. Students should contact the departmental adviser for more details on prerequisites and proficiency requirements. Admission to this program requires satisfying admission requirements in both the computer science and electrical and computer engineering departments.

Students interested in the M.T.S.E. degree whose B.S. degree is not in electrical engineering, computer engineering, or computer science should contact the departmental adviser before applying.

Computer Science Prerequisites		(7)
CS 201	Accelerated Introduction to Computer Science	4
CS 401	Introduction to Advanced Studies I	3
Electrical and Computer Engineering Prerequisites		(14)
ECE 211	Circuit Analysis I	3
ECE 213	Circuit Analysis II	4
ECE 308	Signals and Systems	3
MATH 252	Introduction to Differential Equations	4

Curriculum

The M.T.S.E. is a professional master's degree requiring a minimum of 30 credit hours of adviser-approved coursework. The M.T.S.E. program of studies must include a minimum of 12 credit hours of ECE coursework and a minimum of 12 credit hours of CS coursework.

Master of Telecommunications and Software Engineering, Computer Science Concentration

Required Courses			(12)
CS 586	Software Systems Architectures		3
CS 587	Software Project Management		3
ECE 513	Communication Engineering Fundamentals		3
ECE 541	Performance Evaluation of Computer Networks [1]		3
Elective Categories			(9)
Select a minimum of one course from each of the following elective categories:			9
Software Engineering			
CS 521	Object-Oriented Analysis and Design	3	
CS 537	Software Metrics	3	
CS 589	Software Testing and Analysis	3	
Telecommunication Systems			
CS 544	Computer Networks II: Network Services	3	
CS 548	Broadband Networks	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
ECE 545	Advanced Computer Networks	3	
Telecommunications			
ECE 504	Wireless Communication System Design	3	
ECE 515	Modern Digital Communications	3	
ECE 519	Coding for Reliable Communications	3	
Electives			(9)
Select 9 credit hours [2]			9
Total Credit Hours			30

1 Can be substituted with ECE 542.

2 Elective courses may be chosen from courses listed above, or other courses approved by the M.T.S.E. adviser. Students with no background in communications or software should see the Recommended Courses list below.

Recommended Courses

Students with no background in communications or software engineering should consider including in their programs of study:

CS 450	Operating Systems	3
CS 455	Data Communications	3
CS 487	Software Engineering I	3
ECE 403	Digital and Data Communication Systems	3
Other courses that students in this program typically choose from include:		
ECE 437	Digital Signal Processing I	3
ECE 511	Analysis of Random Signals	3
ECE 514	Digital Communication Principles	3
CS 542	Computer Networks I: Fundamentals	3
CS 588	Advanced Software Engineering Development	3

Master of Science in Computational Decision Sciences and Operations Research

Collaborative program with the Department of Applied Mathematics

The purpose of this program is to provide students with theoretical skills and knowledge of applications in the areas of optimization, game theory, and machine learning to enable them to contribute towards making business decisions more efficient, or alternatively, to enable them to pursue research in these areas.

Admission Requirements

Students with bachelor of science degrees in mathematics, computer science, industrial engineering, electrical and computer engineering, mechanical engineering, and business, or related areas, with a minimum cumulative GPA of at least 3.0/4.0, will be considered. Prospective students should have knowledge of linear algebra, discrete mathematics, probability and statistics, and programming.

All applications will be considered on an individual basis and strong applicants without an adequate background might be admitted with a requirement to take additional prerequisite courses. A statement of objectives and a curriculum vitae must be submitted. Two letters of recommendation are required. GRE scores must meet Illinois Institute of Technology institutional requirements.

Curriculum

Coursework includes 12 credit hours of required core courses and 20 credit hours of elective courses. Up to 12 credit hours of 400-level coursework may be included in the program with adviser approval. A student may, with permission of a thesis adviser, include in his or her program a thesis of up to 5 credit hours consisting of a combination of CS 591 and/or MATH 591. The thesis option requires a written thesis and an oral defense of the thesis. Thesis format and deadlines are set by the Graduate College.

Code	Title		Credit Hours
Core Courses			(12)
CS 430	Introduction to Algorithms		3
or CS 535	Design and Analysis of Algorithms		
MATH 481	Introduction to Stochastic Processes		3
or MATH 564	Applied Statistics		
or MATH 565	Monte Carlo Methods in Finance		
CS 539	Game Theory: Algorithms and Applications		3
or CS 583	Probabilistic Graphical Models		
or MBA 505	Contemporary Economic Analysis and Game Theory		
or MATH 522	Mathematical Modeling		
CS 538	Combinatorial Optimization		3
or MATH 535	Optimization I		
Computing Sciences Electives			(3)
Select a minimum of one course from the following:			3
CS 422	Data Mining	3	
CS 425	Database Organization	3	
CS 520	Data Integration, Warehousing, and Provenance	3	

CS 522	Advanced Data Mining	3	
CS 525	Advanced Database Organization	3	
CS 529	Information Retrieval	3	
CS 584	Machine Learning	3	
CS 595	Topics in Computer Science	3-12	
CS 597	Reading and Special Problems	1-20	
Applied Math Electives			(3)
Select a minimum of one course from the following:			3
MATH 485	Introduction to Mathematical Finance	3	
MATH 522	Mathematical Modeling	3	
MATH 553	Discrete Applied Mathematics I	3	
MATH 554	Discrete Applied Mathematics II	3	
MATH 569	Statistical Learning	3	
MATH 574	Bayesian Computational Statistics	3	
MATH 597	Reading and Special Projects	1-20	
Business and Application Electives			(3)
Select a minimum of one course from the following:			3
BUS 510	Building an Innovative and Sustainable Business	3	
CAE 581	Algorithms in Transportation	3	
MBA 504	Analytics for Decision Making	3	
MBA 513	Operations and Technology Management	3	
MBA 526	Sustainable Supply Chain Management	3	
MSC 511	Economics I	3	
MSC 514	Economics II	3	
Research			(0-5)
Select 0-5 credit hours			0-5
CS 591	Research and Thesis of Masters Degree	1-5	
or MATH 591	Research and Thesis M.S.		
Additional Computational Decision Science and Operations Research Electives			(6-11)
Select 6-11 credit hours [1]			6-11

Minimum degree credits required: 32

1 Courses listed under core courses may be used as an elective if it is not used to fulfill a core requirement. Note: CS 538 and MATH 535 cannot both be taken for credit.
A maximum of 5 credit hours of CS 597 or MATH 597 may be used towards the elective requirement.

Master of Science in Computer Science

The purpose of this program is to prepare students for the Ph.D. program and/or a research/development career in the industry in the field of computer science. Students have the option to pursue thesis research or project under the guidance of a faculty adviser.

Admission requirements include:

- Bachelor's degree from an accredited university with a minimum cumulative GPA of at least 3.0/4.0.
- Minimum GRE scores: 298 (combined quantitative and verbal) and 3.0 (analytical writing).
- For applicants with degrees from schools where the primary language of instruction was not English, a minimum score of 70 on the internet-based TOEFL or 523 on the paper-based TOEFL, 47 on the PTE, or 5.5 on the IELTS exam is required for admission consideration.

Program Requirements

All programs require a core curriculum of 12 credit hours and 20 credit hours of elective courses, which may include a thesis or project. The plan of study must consist of at least 32 credit hours, at least 20 of which must be 500-level computer science courses. Up to 6 credit hours of accelerated courses may be applied to the degree. Master of Science in Computer Science students are not allowed to apply CSP courses towards their degree.

A student may choose from three options to complete the degree:

Option 1

Master's thesis: Coursework and up to 5 credit hours of CS 591 for a total of 32 credit hours. The result is a master's thesis.

Option 2

Master's project: coursework and up to 5 credit hours of CS 597 for a total of 32 credit hours. The result is a project that results in one of the following:

1. A high-quality paper submitted for publication as an article or as a technical report.
2. A high-quality piece of software. The software should be of distribution quality, but can be proprietary.

Option 3

32 credit hours of coursework. A student must complete 32 credit hours of regular coursework including electives and core courses with a GPA of 3.0/4.0 or better.

Students are required to take courses in three core areas: programming, systems, and theory. The student is required to take at least one course from the programming area, at least one course from the systems area, and at least two courses from the theory area. The list below contains the core course offerings in the M.S. program:

Programming Core Courses			(3)
Select a minimum of one course from the following:			3
CS 511	Topics in Computer Graphics	3	
CS 512	Computer Vision	3	
CS 525	Advanced Database Organization	3	
CS 540	Syntactic Analysis of Programming Languages	3	
CS 541	Topics in Compiler Construction	3	
CS 546	Parallel and Distributed Processing	3	
CS 551	Operating System Design and Implementation	3	
CS 553	Cloud Computing	3	
Systems Core Courses			(3)
Select a minimum of one course from the following:			3
CS 542	Computer Networks I: Fundamentals	3	
CS 544	Computer Networks II: Network Services	3	
CS 547	Wireless Networking	3	
CS 550	Advanced Operating Systems	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 570	Advanced Computer Architecture	3	
CS 586	Software Systems Architectures	3	
Theory Core Courses			(6)
Select a minimum of two courses from the following:			6
CS 530	Theory of Computation	3	
CS 533	Computational Geometry	3	
CS 535	Design and Analysis of Algorithms	3	
CS 536	Science of Programming	3	
CS 538	Combinatorial Optimization	3	
CS 539	Game Theory: Algorithms and Applications	3	
General Electives			(15-20)
Select 15-20 credit hours			15-20
Thesis Research			(0-5)
CS 591	Research and Thesis of Masters Degree [1]		0-5
Master's Project			(0-6)
CS 597	Reading and Special Problems [1]		0-6

Minimum degree credits required: 32

1 Up to 6 credit hours of CS 597 may be taken for credit toward the Master of Science in Computer Science degree. Up to 5 credit hours of CS 591 may be taken for credit towards the Master of Science in Computer Science degree. With adviser approval, up to 3 additional credit hours of CS 591 may be added to the degree plan. Students working on a thesis may take a maximum combined total of 8 credit hours of CS 591 and CS 597. For CS 591 hours to count toward a degree, a student must successfully defend a thesis.

Master of Science in Computer Science/Master of Chemical Engineering

Collaborative program with the Department of Chemical and Biological Engineering

This combined program in computer science and chemical engineering addresses the growing need for process engineers with expertise in computational modeling and simulation of chemical processes. Similarly, the program provides a strong engineering background that is required today in many areas of computer science. The program is jointly offered by the Department of Computer Science and the Department of Chemical and Biological Engineering. Students in this program earn both Master of Science in Computer Science and Master of Chemical Engineering degrees.

Students must fulfill the core course requirements of both departments. Students are required to take 18 credit hours in graduate chemical engineering courses (courses numbered 500 or higher) and 26 credit hours in computer science courses (of which 20 credit hours must be 500-level courses).

Curriculum

Code	Title		Credit Hours
Chemical Engineering Courses			(18)
CHE 406	Transport Phenomena		3
CHE 503	Thermodynamics		3
CHE 525	Chemical Reaction Engineering		3
CHE 535	Applications of Mathematics to Chemical Engineering		3
Select a minimum of two courses from the following:			6
CHE 508	Process Design Optimization	3	
CHE 530	Advanced Process Control	3	
CHE 536	Computational Techniques in Engineering	3	
CHE 560	Statistical Quality and Process Control	3	
Any other 500-level course must be approved by the academic adviser			
Computer Science Courses			(26)
Students are required to take at least one course in each of the three core areas (Programming, Systems, and Theory) and 17 credit hours of computer science elective coursework			26
Programming Core Courses			
CS 511	Topics in Computer Graphics	3	
CS 512	Computer Vision	3	
CS 525	Advanced Database Organization	3	
CS 540	Syntactic Analysis of Programming Languages	3	
CS 541	Topics in Compiler Construction	3	
CS 546	Parallel and Distributed Processing	3	
CS 551	Operating System Design and Implementation	3	
CS 553	Cloud Computing	3	
Systems Core Courses			
CS 542	Computer Networks I: Fundamentals	3	
CS 544	Computer Networks II: Network Services	3	
CS 547	Wireless Networking	3	
CS 550	Advanced Operating Systems	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 570	Advanced Computer Architecture	3	
CS 586	Software Systems Architectures	3	
Theory Core Courses			

CS 530	Theory of Computation	3
CS 533	Computational Geometry	3
CS 535	Design and Analysis of Algorithms	3
CS 536	Science of Programming	3
CS 538	Combinatorial Optimization	3
CS 539	Game Theory: Algorithms and Applications	3
Total Credit Hours		44

Doctor of Philosophy in Computer Science

Credit hour requirements: 72 credit hours if without M.S. degree; 49 credit hours if with M.S. degree not in computer science; 40 credit hours if with M.S. degree in computer science

The doctoral program is designed for those students who have an interest in pursuing an academic or industrial research career. To be awarded a Ph.D. in Computer Science, a student must demonstrate mastery in several areas of computer science and must make a significant original contribution to research in the field of computer science. On entry into the program, a student is required to take coursework in a number of areas and pass written and oral qualifying exams. Next, the student must formulate a thesis research problem and present it and the proposed research to a committee of faculty at a comprehensive exam. Upon passing this examination, the student must carry out the research and write and defend a thesis, among other requirements.

Admission to the Ph.D. program is competitive and applicants must have high grade point averages, GRE scores, and (if required) TOEFL scores. Students who enter the program after completing a master's degree (not necessarily in computer science) normally require three to four years of full-time work to complete the Ph.D. Part-time students take longer. Students may also enter the program directly after completing only a bachelor's degree in computer science. The direct program enables bright, highly-motivated students to participate in departmental research programs immediately after their bachelor's degree. Students in the direct program take extra coursework and normally require an additional year to complete the Ph.D. compared to students in the post-master's program.

Requirements for Students Entering with a B.S. Degree

72 credit hours
Qualifying exam
Comprehensive exam
Dissertation and oral defense

Admission Requirements

The applicants should have a B.S degree in computer science. Admission to the program is competitive and depends on a student's GRE score and it is expected that applicants will have a high grade-point average. The minimum required GRE scores are 310 (combined quantitative and verbal) and 4.0 (analytical writing). Non-English speaking applicants without a U.S. degree should have a minimum score of 70 on the internet-based TOEFL or 523 on the paper-based TOEFL; a 47 on the PTE; or a 5.5 on the IELTS; in order to be considered for admission.

If an applicant's TOEFL score is below the minimum, the applicant will be required to take the English Proficiency Exam administered by the university's humanities department. Applicants must submit three letters of recommendation and a personal statement.

Requirements for Students Entering with an M.S. Degree

40-49 credit hours
Qualifying exam
Comprehensive exam
Dissertation and oral defense

Admission Requirements

The applicants should have an M.S degree in computer science or related fields. Admission to the program is competitive and depends on a student's GRE score and it is expected that applicants will have a high grade-point average. The minimum required GRE score is 304 (combined quantitative and verbal) and 3.5 (analytical writing). Non-English speaking applicants without a U.S. degree should have a minimum score of 70 on the internet-based TOEFL or 523 on the paper-based TOEFL; a 47 on the PTE; or a 5.5 on the IELTS; in order to be considered for admission.

If an applicant's TOEFL score is below the minimum, the applicant will be required to take the English Proficiency Exam administered by the university's humanities department. Applicants must submit three letters of recommendation and a personal statement.

Curriculum (for students with a B.S. degree)

The program requires students to complete at least 72 and at most 128 adviser-approved semester credit hours of study. A maximum of 6 credit hours may come from outside the Department of Computer Science. Credits from CS 595 are allowed.

Minimum Credits Required	72
Maximum 400-Level Credit	12
500- and 600-Level Computer Science Coursework Credit	36-54

Required Courses		(16)
Select a minimum of one course from each of the following groups: Theory of Computation, Systems, and Programming Languages		9
Select a minimum of two courses from two of the following groups: Networks and Security, Databases, Software Engineering, or Computational Intelligence		6
CS 695	Doctoral Seminar	1
Readings and Special Problems Courses		(6-12)
CS 597	Reading and Special Problems	6-12
General Electives		(8-26)
Select 8 to 26 credit hours		8-26
Ph.D. Research		(24-36)
CS 691	Research and Thesis Ph.D.	24-36

Notice that no credits will be given to accelerated courses (700-level courses). No credits are given to courses in which the student earns a grade of "C" or below. The student may have to take some other courses as required by the adviser. Advanced courses may be substituted after approval of the department.

M.S. Exit from Program

Students wishing to leave the direct Ph.D. program with the degree of Master of Science in Computer Science must satisfy all the requirements of the master's degree and either write an M.S. thesis or pass the Ph.D. qualifying examination.

Ph.D. Qualifying Examination

The Ph.D. qualifying exam has two parts: a written examination and an oral examination. The written examination is used to judge a student's breadth of knowledge; the oral examination is used to judge a student's research potential. The first attempt in oral examination and the written examination must be taken no later than a student's fifth semester. The second attempt must be taken no later than a student's sixth semester. These requirements hold for both full-time and part-time students. The written examination is divided into three independent area examinations. To pass the written examination, a student must pass all the area examinations.

Area examinations can be taken in the same or different semesters. A student who fails an area examination can retake the area examination, but only once. Passing a relevant core course with "A" when registered in the PhD section of that course qualifies as passing the respective area examination. See the computer science website (science.iit.edu/computer-science) for more detail for qualifying examinations.

Comprehensive (Research Proposal) Examination

The purpose of the comprehensive examination is to ensure that the candidate has the background to carry out successful research in the chosen area and that the research problem is properly formulated and has sufficient scholarly merit. The student (in concert with the student's research adviser) must develop a written research proposal containing a literature review, a proposed research topic, and a program of research based upon this topic, and then present the proposal orally as well.

The student must request appointment of an examination committee using Form G301. The examination committee may consist of from four to seven members. It must include at least three full-time faculty members from the Department of Computer Science and one full-time faculty member from another department in the university. Other committee members from inside or outside the university may be chosen. The student should consult with his/her research adviser concerning the makeup of the committee.

Thesis Defense

Each student must present an oral defense of his/her Ph.D. thesis. The thesis review committee is appointed in much the same way as the Ph.D. comprehensive examination committee. It will examine the written thesis and examine the student during the oral defense. All Ph.D. thesis defenses are open to the public.

Curriculum (for students with a M.S. degree in Computer Science)

If the student has an M.S. degree in computer science, the program requires the student to complete at least 40 adviser-approved semester credit hours of study. A maximum of 6 credit hours may come from outside the Department of Computer Science. Credits from CS 595 are allowed.

Minimum Credits Required	72
Maximum Transfer Credit	32
Maximum 400-Level Credit	12
500- and 600-Level Computer Science Coursework Credit	15-30

Required Courses		(10)
Select a minimum of three courses from three different core course groups as listed below		9
CS 695	Doctoral Seminar	1
Readings and Special Problems Courses		(0-12)
CS 597	Reading and Special Problems [1]	0-12
General Electives		(0-6)
Select 0-6 credit hours		0-6
Ph.D. Research		(24-36)
CS 691	Research and Thesis Ph.D. [1]	24-36
Transfer Credit		(32)
A maximum of 32 hours of masters transfer credit is allowed		32

[1] At least 3 credits of CS 597 or CS 691 are required in the first year.

Notice that no credits will be given to accelerated courses (700-level courses). No credits are given to courses in which the student earns a grade of "C" or below. The student may have to take some other courses as required by the adviser. Advanced courses may be substituted after approval of the department.

Computer Science Core Course Groups

Group I: Theory of Computation		(15)
CS 530	Theory of Computation	3
CS 533	Computational Geometry	3
CS 535	Design and Analysis of Algorithms	3
CS 538	Combinatorial Optimization	3
CS 539	Game Theory: Algorithms and Applications	3
Group II: Systems		(9)
CS 546	Parallel and Distributed Processing	3
CS 550	Advanced Operating Systems	3
CS 570	Advanced Computer Architecture	3
Group III: Programming Languages		(12)
CS 536	Science of Programming	3
CS 540	Syntactic Analysis of Programming Languages	3
CS 541	Topics in Compiler Construction	3
CS 545	Distributed Computing Landscape	3
Group IV: Networks and Security		(12)
CS 542	Computer Networks I: Fundamentals	3
CS 544	Computer Networks II: Network Services	3
CS 549	Cryptography and Network Security	3
CS 558	Advanced Computer Security	3
Group V: Databases		(3)
CS 525	Advanced Database Organization	3
Group VI: Software Engineering		(3)
CS 586	Software Systems Architectures	3
Group VII: Computational Intelligence		(15)

CS 512	Computer Vision	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 584	Machine Learning	3
CS 585	Natural Language Processing	3

Ph.D. Qualifying Examination

The Ph.D. qualifying examination has two parts: a written examination and an oral examination. The written exam is used to judge a student's breadth of knowledge; the oral exam is used to judge a student's research potential. The first attempt at the oral examination and the written examination must be made no later than a student's third semester. The second attempt must be made no later than a student's fourth semester. These requirements hold for both full-time and part-time students.

The written examination is divided into three independent area examinations. To pass the written examination, a student must pass all the area examinations. Area examinations can be taken in the same or different semesters. A student who fails an area examination can retake the area examination, but only once. Passing a relevant core course with "A" when registered in the Ph.D. section of that course qualifies as passing the respective area examination. See the computer science website (science.iit.edu/computer-science) for more detail for qualifying examinations.

Comprehensive (Research Proposal) Examination

The purpose of the comprehensive examination is to ensure that the candidate has the background to carry out successful research in the chosen area and that the research problem is properly formulated and has sufficient scholarly merit. The student (in concert with the student's research adviser) must develop a written research proposal containing a literature review, a proposed research topic, and a program of research based upon this topic, and then present it orally as well.

The student must request appointment of an examination committee on Form G301. The examination committee may consist of from four to seven members. It must include at least three full-time faculty members from the Department of Computer Science and one full-time faculty member from another department in the university. Other committee members from inside or outside the university may be chosen. The student should consult with his/her research adviser concerning the makeup of the committee.

Thesis Defense

Each student must present an oral defense of his/her Ph.D. thesis. The thesis review committee is appointed in much the same way as the Ph.D. comprehensive examination committee. It will examine the written thesis and examine the student during the oral defense. All Ph.D. thesis defenses are open to the public.

Curriculum (for students with a M.S. degree not in Computer Science)

If the student has an M.S. degree in a field other than computer science, the program requires the student to complete at least 49 adviser-approved semester credit hours of study. A maximum of 6 credit hours may come from outside the Department of Computer Science. Credits from CS 595 are allowed.

Minimum Credits Required	72
Maximum Transfer Credit	23
Maximum 400-Level Credit	12
500- and 600-Level Computer Science Coursework Credit	24-30

Required Courses		(16)
Select a minimum of one course from each of the following groups: Theory of Computation, Systems, and Programming Languages		9
Select a minimum of two courses from two of the following groups: Networks and Security, Databases, Software Engineering, or Computational Intelligence		6
CS 695	Doctoral Seminar	1
Readings and Special Problems Courses		(0-12)
CS 597	Reading and Special Problems [1]	0-12
General Electives		(0-9)
Select 0-9 credit hours		0-9
Ph.D. Research		(24-36)
CS 691	Research and Thesis Ph.D. [1]	24-36
Transfer Credit		(23)

A maximum of 23 hours of masters transfer credit is allowed	23

[1] At least 3 credits of CS 597 or CS 691 are required in the first year.

Notice that no credits will be given to accelerated courses (700-level courses). No credits are given to courses in which the student earns a grade of "C" or below. The student may have to take some other courses as required by the adviser. Advanced courses may be substituted after approval of the department.

Computer Science Core Course Groups

Group I: Theory of Computation		(15)
CS 530	Theory of Computation	3
CS 533	Computational Geometry	3
CS 535	Design and Analysis of Algorithms	3
CS 538	Combinatorial Optimization	3
CS 539	Game Theory: Algorithms and Applications	3
Group II: Systems		(9)
CS 546	Parallel and Distributed Processing	3
CS 550	Advanced Operating Systems	3
CS 570	Advanced Computer Architecture	3
Group III: Programming Languages		(12)
CS 536	Science of Programming	3
CS 540	Syntactic Analysis of Programming Languages	3
CS 541	Topics in Compiler Construction	3
CS 545	Distributed Computing Landscape	3
Group IV: Networks and Security		(12)
CS 542	Computer Networks I: Fundamentals	3
CS 544	Computer Networks II: Network Services	3
CS 549	Cryptography and Network Security	3
CS 558	Advanced Computer Security	3
Group V: Databases		(3)
CS 525	Advanced Database Organization	3
Group VI: Software Engineering		(3)
CS 586	Software Systems Architectures	3
Group VII: Computational Intelligence		(15)
CS 512	Computer Vision	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 584	Machine Learning	3
CS 585	Natural Language Processing	3

Ph.D. Qualifying Examination

The Ph.D. qualifying examination has two parts: a written examination and an oral examination. The written exam is used to judge a student's breadth of knowledge; the oral exam is used to judge a student's research potential. The first attempt at the oral examination and the written examination must be made no later than a student's third semester. The second attempt must be made no later than a student's fourth semester. These requirements hold for both full-time and part-time students.

The written examination is divided into three independent area examinations. To pass the written examination, a student must pass all the area examinations. Area examinations can be taken in the same or different semesters. A student who fails an area examination can retake the area examination, but only once. Passing a relevant core course with "A" when registered in the Ph.D. section of that course qualifies as passing the respective area examination. See the computer science website (science.iit.edu/computer-science) for more detail for qualifying examinations.

Comprehensive (Research Proposal) Examination

The purpose of the comprehensive examination is to ensure that the candidate has the background to carry out successful research in the chosen area and that the research problem is properly formulated and has sufficient scholarly merit. The student (in concert with the student's research adviser) must develop a written research proposal containing a literature review, a proposed research topic, and a program of research based upon this topic, and then present it orally as well.

The student must request appointment of an examination committee on Form G301. The examination committee may consist of from four to seven members. It must include at least three full-time faculty members from the Department of Computer Science and one full-time faculty member from another department in the university. Other committee members from inside or outside the university may be chosen. The student should consult with his/her research adviser concerning the makeup of the committee.

Thesis Defense

Each student must present an oral defense of his/her Ph.D. thesis. The thesis review committee is appointed in much the same way as the Ph.D. comprehensive examination committee. It will examine the written thesis and examine the student during the oral defense. All Ph.D. thesis defenses are open to the public.

Certificate in Computational Intelligence

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 480	Artificial Intelligence Planning and Control	3	
CS 512	Computer Vision	3	
CS 522	Advanced Data Mining	3	
CS 579	Online Social Network Analysis	3	
CS 583	Probabilistic Graphical Models	3	
CS 584	Machine Learning	3	
CS 585	Natural Language Processing	3	
Total Credit Hours			9

Certificate in Cyber-Physical Systems

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours of the following:			9
CS 442	Mobile Applications Development	3	
CS 552	Distributed Real-Time Systems	3	
CS 553	Cloud Computing	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
CS 556	Cyber-Physical Systems: Languages and Systems	3	
CS 557	Cyber-Physical Systems: Networking and Algorithms	3	
Total Credit Hours			9

Certificate in Data Analytics

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 422	Data Mining	3	
CS 520	Data Integration, Warehousing, and Provenance	3	
CS 522	Advanced Data Mining	3	
CS 554	Data-Intensive Computing	3	
CS 579	Online Social Network Analysis	3	
CS 583	Probabilistic Graphical Models	3	
CS 584	Machine Learning	3	
CS 585	Natural Language Processing	3	
CSP 571	Data Preparation and Analysis	3	
Total Credit Hours			9

Certificate in Database Systems

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 425	Database Organization	3	
CS 520	Data Integration, Warehousing, and Provenance	3	
CS 521	Object-Oriented Analysis and Design	3	
CS 522	Advanced Data Mining	3	
CS 525	Advanced Database Organization	3	
CS 529	Information Retrieval	3	
CS 553	Cloud Computing	3	
CS 554	Data-Intensive Computing	3	
Total Credit Hours			9

Certificate in Distributed and Cloud Computing

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 451	Introduction to Parallel and Distributed Computing	3	
CS 546	Parallel and Distributed Processing	3	
CS 550	Advanced Operating Systems	3	
CS 552	Distributed Real-Time Systems	3	
CS 553	Cloud Computing	3	
CS 554	Data-Intensive Computing	3	
CS 570	Advanced Computer Architecture	3	
Total Credit Hours			9

Certificate in Information Security and Assurance

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 458	Introduction to Information Security	3	
CS 525	Advanced Database Organization	3	
CS 549	Cryptography and Network Security	3	
CS 558	Advanced Computer Security	3	
CSP 544	System and Network Security	3	
Total Credit Hours			9

Certificate in Networking and Communications

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 455	Data Communications	3	
CS 542	Computer Networks I: Fundamentals	3	
CS 544	Computer Networks II: Network Services	3	
CS 547	Wireless Networking	3	
CS 548	Broadband Networks	3	
CS 549	Cryptography and Network Security	3	
CS 555	Analytic Models and Simulation of Computer Systems	3	
Total Credit Hours			9

Certificate in Software Engineering

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelor's degree from an accredited college or university. The degree need not be in computer science.

Curriculum

Select 9 credit hours from the following:			9
CS 487	Software Engineering I	3	
CS 521	Object-Oriented Analysis and Design	3	
CS 536	Science of Programming	3	
CS 537	Software Metrics	3	
CS 586	Software Systems Architectures	3	
CS 587	Software Project Management	3	
CS 589	Software Testing and Analysis	3	
Total Credit Hours			9

Mathematics and Science Education

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Chicago, IL 60616
312.567.3661
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Chair
TBD

Director, Graduate Programs
N. G. Lederman

Faculty with Research Interests
For more information regarding faculty visit the Department of Mathematics and Science Education website.

Mathematics and science education is primarily concerned with all aspects of the teaching and learning of mathematics and/or science at the secondary levels (i.e., grades 6-12). The department offers professional master's, master of science, and Ph.D. degrees in mathematics and science education. The master's programs are specifically focused on experienced teachers, individuals seeking certification and advanced study, or individuals working in educational settings other than schools (e.g., museums, zoos, etc.). Specific attention is placed on curriculum development, evaluation, advanced instructional models, supervision, learning and cognition, and action research.

The Ph.D. programs are designed for those individuals wishing to become university-level teacher educators and researchers. Extensive attention is given to quantitative and qualitative research designs, along with advanced work in evaluation, curriculum analysis, and supervision. Both M.S. and Ph.D. students will be required to complete additional subject matter courses (e.g. science and mathematics) equivalent to 9-12 credit hours.

Research Areas

Research areas include informal science/math education, curriculum development, integration of science/math disciplines and across disciplines, and instructional methods; students and teachers' conceptions of scientific/mathematic inquiry and nature of science/math, instructional models, evaluation, and research design.

Admission Requirements

Bachelor's (or master's, for Ph.D. programs) degree in mathematics (for mathematics education), science (for science education) or another field with documented evidence of success in working with school-aged youth.

GRE score minimum for M.S. applicants

900 (quantitative + verbal); 2.5 (analytical writing)

GRE score minimum for Ph.D. applicants

1000 (quantitative + verbal); 3.0 (analytical writing)

TOEFL minimum

600/250/80[1] if from non-English speaking country

A minimum cumulative undergraduate GPA of 3.0/4.0
Two-page professional statement of goals/objectives
Curriculum vita
Three letters of recommendation
An interview may be required

Additional requirements for Ph.D. programs

Three years of teaching experience. Meeting the minimum standards does not guarantee admission. Test scores and GPA are just two of several important factors considered, and admission decisions are made based upon the totality of the application file.

1 Paper-based/computer-based/internet-based test score.

Degrees Offered

Course Descriptions

MSED 500
Analysis of Classrooms II (Practicum and Seminar)
This course includes a two-hour seminar on campus each week along with approximately five hours per week in an area school. This is an introductory course that provides students background learning theory, classroom management, aspects of effective teaching, critical classroom variables, and the school as a system.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 501
Advanced Strategies: Mathematics
A course that provides additional exposure and development of instructional strategies and models of mathematics teaching. Special emphasis is placed upon promoting critical thinking and decision making.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 502
Advanced Strategies: Science
A course that provides additional exposure and development of instructional strategies and models of science teaching. Special emphasis is placed upon promoting critical thinking and decision making.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 509
Instructional Strategies for Middle School Mathematics
This course addresses concerns of teaching grades 5 through 8 math by considering the social and psychological characteristics of students in transition from elementary to high school mathematics. The course uses a focus on rational number and reasoning (topics that span middle school curriculum) to study students' development of powerful representational systems and conceptual flexibility. Participants will learn about building mathematical community in which students construct mathematical evidence for claims of perceived regularities and patterns on logical reasoning and mathematical thinking. Participants will select, adapt, and design math tasks to serve instructional purposes and will learn what it means to build an ongoing assessment system that integrates self, peer, teacher, and formative/summative assessment into best practice.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 510
Problem Based Algebra
Algebra is taught via a problem solving approach with connections to other topic areas such as geometry, statistics and probability. Explorations with and conjecturing about number relationships and functions provide experiences from which students develop algebraic habits of mind: Doing and undoing (algebraic thinking that involves reflective or reverse algebraic reasoning, doing problems and organizing data to representation situations in which input is related to output by well-defined functional rules); and abstracting from computation (developing the capacity to think about computations independently of particular numbers used). Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 511
Problem Based Number Theory
Number theory is taught via a problem solving approach with connections to geometry, logic, and probability. Explorations with and conjecturing about number patterns provide experiences from which students study various topics including the following: factors, primes, and prime factorization; counting techniques; greatest common factor (GCF) and least common multiple (LCM); divisibility; number patterns (e.g., Pascal's triangle, polygonal numbers, Pythagorean triples, Fibonacci numbers); Diophantine equations; remainder classes and modular arithmetic; iteration, recursion, and mathematical induction. Basic algebra and instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 512
Philosophy of Science: Key Topics and Applications to K-12 Science Education
This course presents fundamental topics and key issues from philosophy of science (e.g., explanation, representation/models, evidence, laws and causation, confirmation/inductive logic, etc.). The goal of the course is to enrich teachers' understanding of philosophy of science so that they will be better prepared to design instructions both about science content and about NOS and NOSI. To achieve this, each course is explicitly linked to particular subject matter and concepts and/or NOS or NOSI ideas. Teachers will be facilitated to see why and how philosophy of science can inform science instruction.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 513
Problem Based Statistics and Probability
This course emphasizes statistics and probability as practical subjects devoted to obtaining and processing data with a view toward making statements that often extend beyond the data. These statements (i.e., inferences) take the form of estimates, confidence intervals, significance tests, etc. The content of this course is concerned with the production of good data, and involves consideration of experimental designs and sample surveys. The activities have their origin in real data and are concerned with processing the data in the widest contexts and with a wide variety of applications such as social, administrative, medical, the physical sciences and the biological sciences. Basic Algebra and Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 514
Problem-Based Geometry
Geometry is taught via problem solving with connections to other topic areas such as algebra and number theory. Explorations of and conjecturing about fundamental concepts of Euclidean geometry in two and three dimensions and their application provide experiences from which students study various topics including the following: properties and relationships of geometric objects; geometric proof; area and volume; transformations, symmetry, and tessellations; trigonometric ratios; and visual modeling of algebraic operations as well as algebraic abstract concepts.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 517
Problem-Based Calculus
This course is focused on the development of foundational ideas, concepts, and methods of introductory calculus and its basic applications with emphasis on various problem-solving strategies, visualization, mathematical modeling, and connections to algebra, geometry, number theory, and logic relevant to the middle school mathematics curriculum. Explorations with the SimCalc software and conjecturing about linking graphs, tables, and concrete to represent dynamic situations provide experiences from which students study various topics including the following: linear, quadratic, cubic, exponential, logarithmic, and trigonometric functions and their graphs; limits and continuity; rate of change, slope, tangent, and derivative; area under a curve and integration; and elements of infinite series.
Prerequisite(s): [(MSED 320) OR (MSED 514) OR (MSED 520)]AND[(MSED 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 518
History of Science: Key Episodes, Topics, and Applications to K-12 Science Education
This course presents fundamental topics and key issues from history of science (the organization of science, science and religion, science and technology, scientific revolutions, etc.). The goal of the course is to enrich teachers' understanding of history of science so that they will be better prepared to design instructions both about science content and about NOS and NOSI. To achieve this, each course is explicitly linked to particular subject matter and concepts and/or NOS or NOSI ideas. Teachers will be facilitated to see why and how history of science can inform science instruction.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 520
Geometry
The course is focused on selected topics related to fundamental ideas and methods of Euclidean geometry, non-Euclidean geometry, and differential geometry in two and three dimensions and their applications with emphasis on various problem-solving strategies, geometric proof, visualization, and interrelation of different areas of mathematics. Permission of the instructor is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 521
Perspectives in Analysis
This course is focused on selected topics related to fundamental concepts and methods of classic analysis and their applications with emphasis on various problem-solving strategies, visualization, mathematical modeling, and interrelation of different areas of mathematics. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 524
Get Energized -- Physical Science
Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. The course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m.
Lecture: 3 **Lab:** 3 **Credits:** 3

MSED 530
Teacher Education/Professional Development in Science
A course that stresses the empirical research on best practices in teacher education and professional development in science.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 531
Teacher Education/Professional Development in Mathematics
A course that stresses the empirical research on best practices in teacher education and professional development in mathematics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 538
Inquiry and Problem Solving
A group of authentic inquiry experiences supervised by practicing scientists or mathematicians.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 540
Informal Education Practicum
Placement in an informal educational setting such as museums and outdoor education. The focus of this course is on the use of informal setting to supplement classroom instruction.
Lecture: 2 **Lab:** 5 **Credits:** 3

MSED 545
Statistics for Educators I
Part one of a two-part course. The course provides concepts and methods of gathering, describing and drawing conclusions from data. Statistical reasoning, probability, sampling, regression, correlation, forecasting, nonparametric statistics, conceptions and misconceptions about statistics, problem solving techniques and current research are included throughout the course.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 546
Statistics for Educators II
Part two of a two-part course. Statistical reasoning, probability, sampling, regression, correlation, forecasting, nonparametric statistics, conceptions and misconceptions about statistics, problem solving techniques and current research are included throughout the course.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 550
Clinical Supervision in Science/Mathematics
Provides for the development of a variety of classroom observation techniques and clinical supervision skills.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 552
Assessment and Evaluation
Contemporary assessment and evaluation theory and the development of valid cognitive, affective, and psychomotor assessment items/tasks. In-depth attention is given to the development and scoring of alternative assessment techniques such as portfolios and projects.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 554
Middle and Secondary Level Science Curriculum
This course will develop a functional understanding of various factors that influence the development and direction of middle and secondary science curricula. Students will become familiar with strategies to integrate language arts, reading, and writing in the content area of science. Students will apply knowledge of subject matter, curriculum development, and curriculum theory to construct a hypothetical curriculum. Current trends, history of these trends, and rationales for science curriculum reform will be examined.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 555
Middle and Secondary Level Mathematics Curriculum
This course will develop a functional understanding of various factors that influence the development and direction of middle and secondary mathematics curricula. Students will become familiar with strategies to integrate language arts, reading, and writing in the content area of mathematics. Students will apply knowledge of subject matter, curriculum development, and curriculum theory to construct a hypothetical curriculum. Current trends, history of these trends, and rationales for mathematics curriculum reform will be examined.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 560
Research and Evaluation
Analysis of qualitative and quantitative empirical research in science and mathematics education.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 562
Action Research I
Reviewing, designing, and conducting research studies within the context of the students' own teaching.
Credit: Variable

MSED 563
Action Research II
Reviewing, designing, and conducting research studies within the context of the students' own teaching. This course is a continuation of MSED 562.
Lecture: 0 **Lab:** 0 **Credits:** 3

MSED 564
Action Research III
Reviewing, designing, and conducting research studies within the context of the students' own teaching. This course is a continuation of MSED 562 and MSED 563.
Lecture: 0 **Lab:** 0 **Credits:** 3

MSED 570
Inquiry and Nature of Science
Developing a functional understanding of nature of science in the context of scientific inquiry.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 571
Problem Solving and Nature of Mathematics
Developing a functional understanding of nature of mathematics in the context of problem solving.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 580
Adolescent Psychology
This course is designed to develop the participants' understanding of adolescent psychology. The main foci throughout the course are the unique aspects of adolescents and how those aspects influence behavior, learning, and social interactions, especially with regard to middle schools. Studies will include educational psychology theories and models, motivation and learning, developmental changes during adolescence, cognitive abilities, human ecology, diversity, and cultures. Additionally, participants will examine historical and philosophical perspectives of adolescent psychology and synthesize how these perspectives have influenced teaching, learning, and cultures in middle schools. The course will involve weekly readings and reflections, classroom experiences, short assignments, tests/quizzes, research projects, and formal class presentations. Requires admission into the secondary mathematics teacher certification program or instructor permission.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 583
Inquiry, Content and Nature of Science
This course is appropriate for continuing education of secondary education science teachers, who will be engaged in authentic scientific inquiry with practicing research scientists, learning about nature of science, scientific inquiry, and subject matter, and developing pedagogical knowledge and skills related to these concepts. The goal of the Project ICAN is to empower teachers to help their students to work toward scientific inquiry. (Variable:1-3)
Credit: Variable

MSED 584
Inquiry, Context, Nature and Science
Understanding nature of science as it relates to subject matter, and developing pedagogical knowledge and skills related to these concepts.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 591
Research and Thesis M.S.
A course that provides the guidance and opportunity for authentic research projects in Science or Mathematics Education to fulfill thesis requirements for MS Candidates.
Credit: Variable

MSED 594
Special Projects
Advanced projects involving independent study, and especially fieldwork and modeling projects. (Variable: 1-6)
Credit: Variable

MSED 597
Special Problems
Current problems in science/mathematics education. May be repeated for credit with different topics.
Credit: Variable

MSED 598
Methods of College Teaching in Mathematics and Science
The course is designed to allow each student to develop the theoretical background, practical knowledge, and skills for successful college level mathematics or science teaching. Specific emphasis will be placed upon instructional methods/models, curriculum development, and instructional planning.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 599
College Teaching Practicum
The purpose of the course is to enhance college level teacher preparation with an advanced learning experience joining together theory and practice. This course provides the student the opportunity to practice and improve knowledge and skills at teaching. The student may actively participate or act as an observer at a different college. In addition, students are required to prepare a Portfolio. The Portfolio provides the student an opportunity to demonstrate a readiness for teaching that describes their efforts and progress in preparing to teach science or mathematics at the college level.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 601
Critical Analysis in Quantitative Research
A study of quantitative research designs and analytical procedures with critical analysis of perspectives of research in science/ mathematics education.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 602
Quantitative Research Design and Practicum
A study of quantitative research designs, analytical procedures, and in-depth analysis with specific applications in science/mathematics education.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 603
Critical Analysis in Qualitative Research
A study of qualitative research designs and analytical procedures with critical analysis of perspectives of research in science/ mathematics education.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 604
Qualitative Research Design and Praticum
A study of qualitative research designs, analytical procedures, and in-depth analysis with specific applications in science/mathematics education.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSED 691
Ph.D. Thesis Research
A course that provides the guidance and opportunity for authentic research projects in Science or Mathematics Education to fulfill thesis requirements for PhD Candidates. Instructor permission required.
Credit: Variable

Master of Mathematics Education

The objective of the master's program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of mathematics. These advanced studies will enhance graduates' ability to provide meaningful instruction in mathematics; critically analyze and implement empirical research findings in mathematics education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

Curriculum

Required Courses			(24)
MSED 501	Advanced Strategies: Mathematics		3
MSED 538	Inquiry and Problem Solving		3
MSED 540	Informal Education Practicum		3
MSED 550	Clinical Supervision in Science/Mathematics		3
MSED 552	Assessment and Evaluation		3
or MSED 560	Research and Evaluation		
MSED 555	Middle and Secondary Level Mathematics Curriculum		3
MSED 580	Adolescent Psychology		3
Select a minimum of one course from the following:			3
MSED 531	Teacher Education/Professional Development in Mathematics	3	
MSED 562	Action Research I	3	
MSED 571	Problem Solving and Nature of Mathematics	3	
Elective Courses			(9)
Select 9 credit hours of coursework from discipline-specific mathematics courses			9
Total Credit Hours			33

Master of Mathematics Education - Teacher Certification Option

The Master of Mathematics Education (Teacher Certification Option) is designed for individuals who already possess a bachelor's degree (preferably in an area of mathematics) and wish to pursue both a teaching certification and a master's degree. This accelerated course of study allows the student to achieve certification and a master's degree in just 45 credit hours, instead of the 54 credit hours that would be required if certification and master's degree were pursued separately.

Curriculum

Required Courses		(36)
MSED 300	Instructional Methods/Strategies I	3
MSED 400	Instructional Methods/Strategies II	3
MSED 450	Professional Internship	6
MSED 500	Analysis of Classrooms II (Practicum and Seminar)	3
MSED 501	Advanced Strategies: Mathematics	3
MSED 538	Inquiry and Problem Solving	3
MSED 540	Informal Education Practicum	3
MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
MSED 555	Middle and Secondary Level Mathematics Curriculum	3
MSED 580	Adolescent Psychology	3
Elective Courses		(9)
Select 9 credit hours from graduate-level mathematics courses		9
Total Credit Hours		45

Master of Science Education

The objective of the master's program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of science. These advanced studies will enhance graduates' ability to provide meaningful instruction in science; critically analyze and implement empirical research findings in science education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

Curriculum

Required Courses			(24)
MSED 502	Advanced Strategies: Science		3
MSED 538	Inquiry and Problem Solving		3
MSED 540	Informal Education Practicum		3
MSED 550	Clinical Supervision in Science/Mathematics		3
MSED 552	Assessment and Evaluation		3
or MSED 560	Research and Evaluation		
MSED 554/555	Middle and Secondary Level Science Curriculum		3
MSED 580	Adolescent Psychology		3
Select a minimum of one course from the following:			3
MSED 530	Teacher Education/Professional Development in Science	3	
MSED 562	Action Research I	3	
MSED 570	Inquiry and Nature of Science	3	
Elective Courses			(9)
Select 9 credit hours of coursework from discipline-specific science courses			9
Total Credit Hours			33

Master of Science Education - Teacher Certification Option

The Master of Science Education (Teacher Certification Option) is designed for individuals who already possess a bachelor's degree (preferably in an area of science) and wish to pursue both a teaching certification and a master's degree. This accelerated course of study allows the student to achieve certification and a master's degree in just 45 credit hours, instead of the 54 credit hours that would be required if certification and master's degree were pursued separately.

Curriculum

Required Courses		(36)
MSED 300	Instructional Methods/Strategies I	3
MSED 400	Instructional Methods/Strategies II	3
MSED 450	Professional Internship	6
MSED 500	Analysis of Classrooms II (Practicum and Seminar)	3
MSED 502	Advanced Strategies: Science	3
MSED 538	Inquiry and Problem Solving	3
MSED 540	Informal Education Practicum	3
MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
MSED 554	Middle and Secondary Level Science Curriculum	3
MSED 580	Adolescent Psychology	3
Elective Courses		(9)
Select 9 credit hours from graduate-level science courses		9
Total Credit Hours		45

Master of Science in Mathematics Education

The objective of the master's program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of mathematics. These advanced studies will enhance graduates' ability to provide meaningful instruction in mathematics; critically analyze and implement empirical research findings in mathematics education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

Curriculum

Required Courses		(18)
MSED 501	Advanced Strategies: Mathematics	3
MSED 540	Informal Education Practicum	3
MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
or MSED 560	Research and Evaluation	
MSED 555	Middle and Secondary Level Mathematics Curriculum	3
MSED 580	Adolescent Psychology	3
Thesis Research		(6)
MSED 591	Research and Thesis M.S.	6
Elective Courses		(9)
Select 9 credit hours of coursework from discipline-specific mathematics courses		9
Total Credit Hours		33

Master of Science in Mathematics Education with STEM Leadership Cohort

The objective of the Master of Science in Mathematics Education with STEM Leadership Cohort is to provide practicing teachers or individuals in education-related fields with advanced education in the teaching and learning of mathematics education with a strong focus on STEM education. The Mathematics Education STEM Leadership Cohort provides a condensed, one-year master's program for teachers. The program will enhance graduates' abilities to provide meaningful instruction, analyze and implement research findings, develop curriculum, and to become leaders in education at the local and state level.

Curriculum

MSED 501	Advanced Strategies: Mathematics	3
MSED 531	Teacher Education/Professional Development in Mathematics	3
MSED 538	Inquiry and Problem Solving	3
MSED 540	Informal Education Practicum	3
MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
MSED 555	Middle and Secondary Level Mathematics Curriculum	3
MSED 562	Action Research I	3
MSED 563	Action Research II	3
MSED 564	Action Research III	3
MSED 597	Special Problems	3
Total Credit Hours		33

Master of Science in Science Education

The objective of the master's program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of science. These advanced studies will enhance graduates' ability to provide meaningful instruction in science; critically analyze and implement empirical research findings in science education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

Curriculum

Required Courses		(18)
MSED 502	Advanced Strategies: Science	3
MSED 540	Informal Education Practicum	3
MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
or MSED 560	Research and Evaluation	
MSED 554	Middle and Secondary Level Science Curriculum	3
MSED 580	Adolescent Psychology	3
Thesis Research		(6)
MSED 591	Research and Thesis M.S.	6
Elective Courses		(9)
Select 9 credit hours of coursework from discipline-specific science courses		9
Total Credit Hours		33

Master of Science in Science Education with STEM Leadership Cohort

The objective of the Master of Science in Mathematics Education with STEM Leadership Cohort is to provide practicing teachers or individuals in education-related fields with advanced education in the teaching and learning of science education with a strong focus on STEM education. The Science Education STEM Leadership Cohort provides a condensed, one-year master's program for teachers. The program will enhance graduates' abilities to provide meaningful instruction, analyze and implement research findings, develop curriculum, and to become leaders in education at the local and state level.

Curriculum

MSED 502	Advanced Strategies: Science	3
MSED 530	Teacher Education/Professional Development in Science	3
MSED 538	Inquiry and Problem Solving	3
MSED 540	Informal Education Practicum	3
MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
MSED 554	Middle and Secondary Level Science Curriculum	3
MSED 562	Action Research I	3
MSED 563	Action Research II	3
MSED 564	Action Research III	3
MSED 597	Special Problems	3
Total Credit Hours		33

Doctor of Philosophy in Collegiate Mathematics Education

85 credit hours beyond the bachelor's degree[1]
Qualifying exam
Comprehensive exam
Dissertation and defense

This joint Ph.D. program is offered through the collaboration of the Department of Applied Mathematics and the Department of Mathematics and Science Education. The objective of the program is to provide advanced education in the teaching and learning of collegiate mathematics through coursework and original research. These advanced studies will enable graduates to teach a wide range of college-level mathematics courses, conduct theoretical and practical research on collegiate mathematics teaching and learning, or develop and evaluate college mathematics curriculum.

1 32 credit hours maximum transfer from master's coursework; 42 credit hours maximum transfer of graduate coursework; the number of subjects allowed for transfer credit depends on what subjects have been recently taken and is decided on a case-by-case basis.

Admission Criteria

Admission to the joint Ph.D. program in collegiate mathematics education requires:

- A master's or bachelor's degree in mathematics or applied mathematics. Candidates whose degree is in another related field (such as computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply.
- GRE score 1100 (quantitative and verbal); 3.0 (analytical writing)
- TOEFL (minimum score of 600 for paper-based, 250 for computer-based, and 100 for internet-based test) if from a non-English speaking country
- A minimum GPA of 3.0/4.0 is required
- Professional statement of goals/objectives (two pages)
- Vita
- Three letters of recommendation
- An interview may be required

Curriculum

Applied Mathematics Core Requirements			(18)
MATH 476	Statistics		3
MATH 500	Applied Analysis I		3
MATH 515	Ordinary Differential Equations and Dynamical Systems		3
MATH 532	Linear Algebra		3
MATH 553	Discrete Applied Mathematics I		3
MATH 577	Computational Mathematics I		3
Mathematics and Science Education Core Requirements			(18)
MSED 598	Methods of College Teaching in Mathematics and Science		3
MSED 599	College Teaching Practicum		3
MSED 601	Critical Analysis in Quantitative Research		3
MSED 602	Quantitative Research Design and Practicum		3
MSED 603	Critical Analysis in Qualitative Research		3
MSED 604	Qualitative Research Design and Praticum		3
Applied Mathematics Electives			(12)
Select a minimum of 12 credit hours from the following:			12
MATH 402	Complex Analysis	3	
MATH 420	Geometry	3	
MATH 475	Probability	3	
Any 500-level applied mathematics course			
Mathematics and Science Education Electives			(9)
Select a minimum of 9 credit hours from the following:			9
MSED 501	Advanced Strategies: Mathematics	3	

MSED 550	Clinical Supervision in Science/Mathematics	3
MSED 552	Assessment and Evaluation	3
MSED 555	Middle and Secondary Level Mathematics Curriculum	3
MSED 571	Problem Solving and Nature of Mathematics	3
Elective Courses		(3)
Select 3 credit hours		3
Ph.D. Research		(25)
MSED 691	Ph.D. Thesis Research	25
Total Credit Hours		85

The qualifying exam is fulfilled by achieving better than a 3.5/4.0 GPA on the MATH 476, MATH 500, MATH 553, and MATH 577 Applied Mathematics (AM) core courses and a 3.5/4.0 GPA on the MSED 601, MSED 602, MSED 603, and MSED 604 Mathematics and Science Education (MSED) core courses and passing an oral examination within the first five semesters of Ph.D. study. The oral exam consists of two one-hour parts covering AM and MSED core courses respectively. For the AM part, the candidate selects any two out of the four above-mentioned AM core courses plus another AM core course to be tested on during the oral exam. For the MSED part, the candidate proposes five position statements ranked by the faculty. The MSED oral exam is composed of the two position statements with the highest rankings:

1. Position statement 1: Written defense to support position with empirical research
2. Position statement 2: Oral defense

The comprehensive exam consists of an oral examination based on the student's research proposal. The exam aims to ensure that the student has the background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit.

A minimum of 25 credit hours should be devoted to thesis research (MSED 691). The dissertation is expected to contain a distinct and substantial, original, and publishable contribution to the field of study. An oral examination in defense of the thesis constitutes completion of the degree.

Doctor of Philosophy in Mathematics Education

84 credit hours (minimum of 51 credit hours of coursework)
Qualifying exam within the first two years of Ph.D. study

- Composed of five position statements (ranked by faculty)
- Top three ranked must be defended orally and in writing

Oral comprehensive exam with the student's graduate committee (the dissertation proposal is presented orally as part of the comprehensive examination)
Oral dissertation defense, involving the final thesis exam

The objective of the Ph.D. program is to provide students with advanced education in the teaching and learning of mathematics. These advanced studies will enable graduates to conduct theoretical and practical research in mathematics education; develop and evaluate curriculum; prepare future teachers; provide professional development to in-service teachers; or become a leader in public school education at the state or local levels.

Curriculum

Required Courses			(30)
MSED 545	Statistics for Educators I		3
MSED 546	Statistics for Educators II		3
MSED 550	Clinical Supervision in Science/Mathematics		3
MSED 552	Assessment and Evaluation		3
MSED 555	Middle and Secondary Level Mathematics Curriculum		3
MSED 580	Adolescent Psychology		3
MSED 601	Critical Analysis in Quantitative Research		3
MSED 602	Quantitative Research Design and Practicum		3
MSED 603	Critical Analysis in Qualitative Research		3
MSED 604	Qualitative Research Design and Praticum		3
Electives			(29)
Select a minimum of 9 credit hours from the following:			9
MSED 501	Advanced Strategies: Mathematics	3	
MSED 531	Teacher Education/Professional Development in Mathematics	3	
MSED 538	Inquiry and Problem Solving	3	
MSED 540	Informal Education Practicum	3	
MSED 560	Research and Evaluation	3	
MSED 562	Action Research I	1-3	
MSED 571	Problem Solving and Nature of Mathematics	3	
MSED 594	Special Projects	1-6	
MSED 597	Special Problems	1-9	
Up to 8 credit hours from discipline-specific graduate coursework			8
12 credit hours of select coursework from discipline-specific mathematics courses/related fields			12
Ph.D. Research			(25)
MSED 691	Ph.D. Thesis Research (minimum 25 credit hours)		25
Total Credit Hours			84

42 maximum transfer of graduate credit hours from master's (24 credit hours from coursework/8 credit hours from research)

Doctor of Philosophy in Science Education

84 credit hours (minimum 51 credit hours of coursework)
Qualifying exam within the first two years of Ph.D. study:

- Composed of five position statements (ranked by faculty)
- Top three ranked must be defended orally and in writing

Oral comprehensive exam with the student's graduate committee (the dissertation proposal is presented orally as part of the comprehensive examination)
Oral dissertation defense, involving the final thesis exam

The objective of the Ph.D. program is to provide students with advanced education in the teaching and learning of science. These advanced studies will enable graduates to conduct theoretical and practical research in science education; develop and evaluate curriculum; prepare future teachers; provide professional development to in-service teachers; or become a leader in public school education at the state or local levels.

Curriculum

Required Courses			(30)
MSED 545	Statistics for Educators I		3
MSED 546	Statistics for Educators II		3
MSED 550	Clinical Supervision in Science/Mathematics		3
MSED 552	Assessment and Evaluation		3
MSED 554	Middle and Secondary Level Science Curriculum		3
MSED 580	Adolescent Psychology		3
MSED 601	Critical Analysis in Quantitative Research		3
MSED 602	Quantitative Research Design and Practicum		3
MSED 603	Critical Analysis in Qualitative Research		3
MSED 604	Qualitative Research Design and Praticum		3
Electives			(29)
Select a minimum of 9 credit hours from the following:			9
MSED 502	Advanced Strategies: Science	3	
MSED 530	Teacher Education/Professional Development in Science	3	
MSED 538	Inquiry and Problem Solving	3	
MSED 540	Informal Education Practicum	3	
MSED 562	Action Research I	1-3	
MSED 570	Inquiry and Nature of Science	3	
MSED 594	Special Projects	1-6	
MSED 597	Special Problems	1-9	
Up to 8 credit hours from discipline-specific graduate coursework			8
12 credit hours of select coursework from discipline-specific science courses/related fields			12
Ph.D. Research			(25)
MSED 691	Ph.D. Thesis Research (minimum 25 credit hours)		25
Total Credit Hours			84

42 maximum transfer of graduate credit hours from master's (24 credit hours from coursework/8 credit hours from research)

Physics

Robert A. Pritzker Research Center
3101 S. Dearborn St.
Chicago, IL 60616
312.567.3579
kersh@iit.edu
science.iit.edu/physics

Chair
Grant Bunker

Faculty with Research Interests
For more information regarding faculty visit the Department of Physics website.

The Department of Physics offers B.S., M.S., and Ph.D. degrees in physics. Within the department, there are many opportunities for interdisciplinary education and research experiences; students in any of the disciplines have easy access to the expertise that the full faculty brings. In addition, the department offers a professional master's degree and related certificate program for part-time students, both on campus and through distance learning.

Research Centers

Center for Accelerator and Particle Physics
Center for the Molecular Study of Soft and Condensed Matter
Center for Synchrotron Radiation Research and Instrumentation

Research Facilities

The department has state-of-the-art computer and laboratory equipment and conducts research in the areas of elementary particle physics, accelerator and plasma physics, condensed-matter physics, biological physics, x- ray optics, x-ray imaging, and quantum theory. The department constructs and operates facilities for x-ray scattering, spectroscopy, and imaging at the Advanced Photon Source at Argonne National Laboratory. Additional research facilities include on-campus x-ray diffraction facilities, thin-film growth facilities, a high-field nuclear magnetic resonance facility, Fourier transform infrared spectrometers, and atomic force microscopes. Laboratories for experimental research in biophysics, low-temperature, solid-state physics, and particle physics are active. Collaborative programs are carried on with Fermi National Accelerator Laboratory, Argonne National Laboratory, and the Advanced Photon Source. The department hosts the Center for Accelerator and Particle Physics (CAPP), the Center for the Molecular Study of Soft and Condensed Matter, and the Center for Synchrotron Radiation Research and Instrumentation (CSRRI).

Departmental Graduate Examinations

All full-time students in the M.S. and Ph.D. programs are required to take and pass the written M.S. comprehensive/Ph.D. qualifying examination by the end of their fourth semester of study. Part-time students must pass this examination by a comparable stage of their programs. The examination is offered twice each academic year. A student may sit officially for the examination a maximum of two times. Students passing this examination at the Ph.D. level are judged to be qualified to continue in the Ph.D. program. Students passing at the master of science level or above may obtain their master's degree after completing the requirements described in the following sections. All students in the Ph.D. program who have passed the written qualifying examination must take and pass a comprehensive examination at least one year prior to the final oral defense. Part-time students must pass this examination by a comparable stage of their programs. The comprehensive examination consists of a written proposal, an oral presentation, and a defense of the proposal before a faculty committee. A student may take this examination a maximum of two times. Students passing this examination may continue with their research and will receive a Ph.D. upon satisfactory completion of all other required courses and general requirements of the Graduate College, a written dissertation, and final oral thesis defense.

All students in the professional master's degree program are required to take and pass a comprehensive exam. Students may sit for the exam a limited number of times.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0

TOEFL minimum: 550/213/80[1]

The Graduate Record Examination (GRE) is required for all applicants. The GRE minimum scores are:

MAS

295 (quantitative + verbal); 2.5 (analytical writing)

M.S.

295 (quantitative + verbal); 2.5 (analytical writing)

Ph.D.

310 (quantitative + verbal); 3.0 (analytical writing)

Applicants to the doctoral program in physics are strongly encouraged, but not required, to take the subject-area GRE exam in physics.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Applicants to the department's program are expected to have a bachelor's degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the MAS or M.S. comprehensive/Ph.D. qualifying examination.

1 Paper-based/computer-based/internet-based test score.

The department offers programs leading to M.S. and Ph.D. degrees in physics, along with a M.S. degree in applied physics. The M.S. degree is not a prerequisite for the Ph.D. The department also offers a professional master's program in health physics designed for both the part-time and full-time student and available through distance learning. Research is organized into small groups of faculty members, post-doctoral associates, graduate students, and undergraduate students working on closely related projects. The principal active areas include experimental and theoretical condensed matter physics, experimental and theoretical elementary particle physics, synchrotron radiation physics, accelerator physics, structural and computational biophysics, magnetism, and electrodynamics. Classes are generally small and informal, and thesis research is carried out in close collaboration with the faculty adviser.

In recognition of the value of teaching experience in strengthening an individual's understanding of his or her field of study and as an aid in making career decisions, the department requires full-time students to participate in instructional activities. Each new graduate student is assigned a graduate student adviser and must obtain the approval of the adviser each semester before registering for any graduate classes.

Degrees Offered

- Master of Health Physics (p. 309)
- Master of Science in Applied Physics (p. 310)
- Master of Science in Physics (p. 311)
- Doctor of Philosophy in Physics (p. 312)

Co-Terminal Options

Bachelor of Science in Physics/Master of Health Physics

Undergraduate students may register for the co-terminal Bachelor of Science in Physics/Master of Health Physics after the fourth semester of study. Students must fulfill the requirements of both the Bachelor of Science in Physics and the Master of Health Physics. A full course of study is approximately ten semesters of study, and graduate coursework typically begins in the fourth year. For further details, refer to Synopsis of Co-Terminal Studies section (p. 33) in this bulletin.

Certificate Program

- Radiological Physics (p. 313)

Course Descriptions

PHYS 501
Methods of Theoretical Physics I
Vector analysis including curvilinear coordinates. Tensor algebra. Ordinary differential equations and special functions. Complex variables algebra, Cauchy-Riemann conditions, harmonic functions. Cauchy theorem, Cauchy formula. Laurent series. Residues calculus, calculation of integrals using residues. Partial differential equations: separation of variables, Fourier series methods. Laplace, wave, diffusion equations in Cartesian, cylindrical and spherical systems of coordinates. Special functions and orthogonal polynomials: Bessel functions, Legendre polynomials, associated Legendre polynomials, Hermite, Laguerre, etc. polynomials.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 502
Methods of Theoretical Physics II
Green functions. Their connection with a complex variables calculus. Advanced, retarded, causal GF. Group theory. Discrete groups, elementary examples and properties. Lie groups, their fundamental properties, applications in quantum mechanics. O(3), SU(2), SU(3), Lorentz groups and their applications in quantum theory. Basic ideas of differential geometry and topology. Path integrals. Special topics specified on the year-by-year basis.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 505
Electromagnetic Theory
Maxwell equations including a derivation of their macroscopic version. Electrostatics, magnetostatics. Electromagnetic waves, dipole radiation, beyond the dipole radiation (quadruple and magneto-dipole radiation); scattering of electromagnetic waves. Gradient (gauge) invariance, special relativity, Lorentz invariant formulation of electrodynamics, Maxwell equations in relativistic invariant form; Lienard-Wiechert fields, relativistic charge electromagnetic field, basic ideas of synchrotron radiation.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 508
Analytical Dynamics
Newton's laws. Lagrange's equations. Central forces. Invariance properties and conservation laws. Collections of particles. Rigid body motions. Small vibrations. Hamilton's equations. Canonical transformations. Hamilton-Jacobi theory. Approximation methods. Special theory of relativity. Classical theory of fields. Undergraduates may take the course with permission of their advisor and their instructor.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 509
Quantum Theory I
Survey of solutions to the Schrodinger Equation in one, two, and three dimensions. Hydrogen, helium, and other atoms. Spin 1/2 particles. Entangled states. EPR Paradox. Bell's Theorem. Formalism of quantum mechanics. Magnetic fields in quantum mechanics. Aharonov-Bohm Effect. Berry's Phase. Time Independent Perturbation Theory. Spin-orbit coupling. Variational method. WKB Method. Many electron wavefunction. Pauli Principle. More detailed look at excited states of helium atom. Time Dependent Perturbation Theory. Fermi's Golden Rule. Lifetime of excited atomic states.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 510
Quantum Theory II
Algebra of angular momenta. Rotation Group. Abstract group theory, Lie algebra, generators, structure constants. O(3), SU(2), SU(3), Lorentz group examples. Scattering theory. S-matrix. Lippmann-Schwinger Equation. Partial wave analysis. Second quantization. Its applications. Bogolyubov transformations. Relativistic Quantum Mechanics. Klein-Gordon Equation. Dirac Equation.
Prerequisite(s): [(PHYS 405 and PHYS 406) OR (PHYS 509 with min. grade of C)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 515
Statistical Mechanics
Ensembles and distribution functions. Classical gases and magnetic systems. Ideal Quantum Gases. Interacting systems. Real Space Renormalization group and critical phenomena. Quantum Statistical Mechanics: Superfluidity and superconductivity. Fluctuations and dissipation.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 518
General Relativity
Lorentz transformations, Minkowski space, 4D vectors and tensors, kinematics and dynamics of special relativity. Riemann geometry, Christoffel symbols, covariant derivatives, geodesics, curvature tensor, Einstein equations. Classical experiments of general relativity, Schwarzschild solution, physics of black holes. Cosmology, Big Bang theory, gravitational waves. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 520
Bio-Nanotechnology
In this multidisciplinary course, we will examine the basic science behind nanotechnology and how it has infused itself into areas of nanofabrication, biomaterials, and molecular medicine. This course will cover materials considered basic building blocks of nanodevices such as organic molecules, carbon nanotubes, and quantum dots. Top-down and bottom-up assembly processes such as thin film patterrning through advanced lithography methods, self-assembly of molecular structures, and biological systems will be discussed. Students will also learn how bionanotechnology applies to modern medicine, including diagnostics and imaging and nanoscale, as well as targeted, nanotherapy and finally nanosurgery.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 537
Solid State Physics I
Crystal structure and crystal binding. Free electron model of metals and semiconductors. Energy band theory. Elastic Properties. Lattice Waves, Dielectric properties.
Prerequisite(s): [(PHYS 509 and PHYS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 538
Solid State Physics II
Higher order susceptibility, spin-orbit coupling, optical absorption, superconductivity. Properties of metals, semiconductors, and insulators. Device physics. Magnetic properties of materials.
Prerequisite(s): [(PHYS 509 and PHYS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 539
Physical Methods of Characterization
A survey of physical methods of characterization including x-ray diffraction and fluorescence surface techniques including SEM, TEM, AES and ESCA, thermal methods and synchrotron radiation methods. Same as CHEM 509.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 545
Particle Physics I
The course is an introduction to and overview of the field of elementary particle physics. No previous exposure is assumed. The first third of the course is devoted to the symmetries of the strong interaction. The second third is a modern introduction to the gauge theories of the electromagnetic, strong, and weak interactions, and their leading evaluation via Feynman diagrams. The final third introduces topics of current and speculative research.
Prerequisite(s): [(PHYS 509 and PHYS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 546
Particle Physics II
The course is a continuation of PHYS 545, but it is self-contained. The goal is to provide a functional understanding of particle physics phenomenology of QED, QCD, and electroweak physics. Topics include QED: Spin-dependent cross sections, crossing symmetries, C/P/CP; QCD: Gluons, parton model, jets; Electroweak interactions: W, Z, and Higgs. Weak decays and production of weak bosons; Loop calculations: Running couplings, renormalization.
Prerequisite(s): [(PHYS 509 and PHYS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 553
Quantum Field Theory
Quantum field theory is a language to understand large numbers of degrees of freedom in most areas of physics such as high energy, statistical, and condensed matter physics. Topics covered include: canonical quantization of fields; path integral quantizations of scalar, Dirac, and gauge theories; symmetries and conservation laws; perturbation theory and generating functionals; regularization and renormalization.
Prerequisite(s): [(PHYS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 561
Radiation Biophysics
Energy loss by ionizing radiation. Target theory. Direct and indirect action. Radiation effects in biomolecules. Radiation inactivation of enzymes, nucleic acids, and viruses. Biological effects of ultraviolet radiation. Photosensitization. Radiation protection and sensitization. Radiation effects in vivo, radiation therapy, and phototherapy.
Prerequisite(s): [(PHYS 410)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 563
Project Management: Business Principles
The course will cover a wide range of business principles highlighting project management and the components of business that employees may encounter. The goal of the course is to help the student understand basic business principles and project management skills, help the student understand the application of organizational behavior in today's workplace and equip the student to function more effectively both independently and as a team in today's organizations.
Lecture: 2 **Lab:** 0 **Credits:** 2

PHYS 566
Environmental Health Physics
Impact of ionizing radiation and radionuclides on the environment. Identifying environmental effects of specific natural and artificial nuclides. Models for deposition and transport of nuclides, including air and water disbursement. Environmental dosimetry and remediation. Facility decommissioning and decontamination.
Prerequisite(s): [(PHYS 572)]
Lecture: 2 **Lab:** 0 **Credits:** 2

PHYS 570
Introduction to Synchrotron Radiation
Production and characterization of synchrotron radiation, dynamical and kinematical diffraction, absorption and scattering processes, x-ray optics for synchrotron radiation and x-ray detectors. Overview of experimental techniques including XAFS, XPS, SAXS, WAXS, diffraction, inelastic x-ray scattering, fluorescence spectroscopy, microprobe, tomography and optical spectroscopy.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 571
Radiation Physics
Fundamentals of Radiation Physics will be presented with an emphasis on problem-solving. Topics covered are review of atomic and nuclear physics; radioactivity and radioactive decay law; and interaction of radiation with matter, including interactions of heavy and light charged particles with matter, interactions of photons with matter, and interactions of neutrons with matter.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 572
Introduction to Health Physics
Health Physics profession; Units in radiation protection; Radiation sources; Interaction od ionizing radiation with matter; Detectors for radiation protection; Biological effects of ionizing radiation; Introduction to microdosimetry; Medical health physics; Fuel cycle health physics; Power reactor health physics; University health physics; Accelerator health physics; Environmental health physics; Radiation accidents.
Prerequisite(s): [(PHYS 571)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 573
Standards, Statutes and Regulations
This course studies the requirements of agencies that regulate radiation hazards, their basis in law and the underlying US and international standards. An array of overlapping requirements will be examined. The effect regulatory agencies have upon the future of organizations and the consequences of noncompliance are explored.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 574
Introduction to the Nuclear Fuel Cycle
This course introduces the concept and components of nuclear fuel cycle that originated from the mining of uranium through the production and utilization of nuclear fuel to the nuclear/radioactive waste generation and disposal. The mechanisms of normal operations through the fuel cycle process will be discussed as well as the accidental situations with expanded coverage on nuclear reactor issues. Emphasis will be placed on the radiological health and safety aspects of the operations. The study will also include key regulatory compliance issues.
Lecture: 2 **Lab:** 0 **Credits:** 2

PHYS 575
Case Studies in Health Physics
This is a non-instructional course designed to promote the understanding of radiation safety through lessons learned from the past incidents. The focus will be on the means for improving the future operations of the acilities/devices. The course is recommended to be among the last courses taken by students who have gained at least one year of academic exposure in health physics and with some level of capability in to address the underlying technical aspects.
Prerequisite(s): [(PHYS 571, PHYS 572, and PHYS 573)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 576
Radiation Dosimetry
This course is to study the science and technique of determining radiation dose and is fundamental to evaluating radiation hazards and risks to humans. This course covers both external dosimetry for radiation sources that are outside the human body and internal dosimetry for intake of radioactive materials into the human body. Topics will include: dosimetry recommendations of ICRP for occupational exposure; US NRC and DOE requirements for particular work environments; and MIRD methodology for medical use of radionuclides.
Prerequisite(s): [(PHYS 571 and PHYS 572*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 577
Operational Health Physics
Covers the basic principles for establishing and maintaining an effective institutional radiation safety program including the following: facility design criteria; organizational management issues; training; internal and external radiation control; radioactive waste disposal; environmental monitoring; radiation safety instrumentation; ALARA program; and emergency response planning. The course will also cover facility licensing/registration with state and federal agencies and legal issues such as institutional and individual liability, fines, violations, and worker rights and responsibilities.
Lecture: 2 **Lab:** 0 **Credits:** 2

PHYS 578
Medical Health Physics
Medical Health Physics (MHP) profession; sources of radiation in the medical environment; radioisotopes in nuclear medicine; diagnostic use of X-rays (radiography, mammography, CT, fluoroscopy); therapeutic use of X-ray and gamma radiation (Co-60 and LINAC based radiation therapy); radiotherapy using sealed radioisotopes (brachytherapy); radiation protection in diagnostic and interventional radiology; radiation protection in nuclear medicine; radiation protection in external beam radiotherapy; radiation protection in brachytherapy; radiation accidents in medicine.
Lecture: 2 **Lab:** 0 **Credits:** 2

PHYS 580
Introduction to Radiochemistry
This course is designed to introduce the fundamental principle of radiation science for students majoring in radiochemistry.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 581
Radiochemistry Laboratory
This laboratory-related course will offer opportunities for students to have hands-on experience in samples preparation, source preparation, and counting measurements.
Lecture: 1 **Lab:** 2 **Credits:** 3

PHYS 582
Applications of Radiochemistry
This course will provide discussion and overview of practical applications of radiochemistry. Various special topics in the following five general series of practical radiochemistry will be offered. Each series covers different topics related to that particular discipline.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 585
Physics Colloquium
Lectures by invited scientists in areas of physics generally not covered in the department. May be taken twice by M. S. students to fulfill course credit requirements.
Lecture: 0 **Lab:** 0 **Credits:** 1

PHYS 591
Research and Thesis M.S.
(Credit: variable)Prerequisite: Instructor permission required.
Credit: Variable

PHYS 597
Reading and Special Problems
Independent study to meet the special needs of graduate students in department-approved graduate degree programs. Requires the written consent of the instructor. May be taken more than once. Receives a letter grade. (Credit: variable) Prerequisite: Instructor permission required.
Credit: Variable

PHYS 600
Continuation of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

PHYS 685
Physics Colloquium
Lectures by invited scientists in areas of physics generally not covered in the department. Must be taken twice by M. S. students and four times by Ph. D. students. May be substituted by PHYS 585 for M. S. students.
Lecture: 0 **Lab:** 0 **Credits:** 0

PHYS 691
Research and Thesis Ph.D.
(Credit: Variable)
Credit: Variable

PHYS 770
Instrumentation for Health Physics
Detecting and measuring radioactive material and radiation levels depends upon many types of detectors and instrumentation. Theory of detectors ranging from chambers operating in pulse and current producing modes to solid state detectors is applied to measuring and monitoring systems. Electronics ranging from simple rate meters and scalers to high speed multi-channel analyzers is used. Computer linked instrumentation and computer based applications are applied to practical problems.
Lecture: 3 **Lab:** 4 **Credits:** 3

SCI 511
Project Management
Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 522
Public Engagement for Scientists
This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

Master of Health Physics

Designed primarily for working professional health physicists in government, medicine, research, and industry, this program combines technical depth with the interdisciplinary viewpoints of leadership, management, and communications. The degree can be completed in four semesters and two summer sessions of part-time study. Applicants must have completed coursework in calculus through differential equations and a calculus-based general physics sequence. A course in modern physics, including some basic quantum mechanics, is strongly recommended. A comprehensive examination is required for the degree.

This program is also available on the web, and at televised viewing sites throughout the Chicago area. Students should consult online.iit.edu for more information.

Curriculum

Required Courses			(31)
PHYS 561	Radiation Biophysics		3
PHYS 571	Radiation Physics		3
PHYS 572	Introduction to Health Physics		3
PHYS 573	Standards, Statutes and Regulations		3
PHYS 575	Case Studies in Health Physics		3
PHYS 576	Radiation Dosimetry		3
PHYS 770	Instrumentation for Health Physics		3
Select a minimum of two courses from the following:			6
CHEM 513	Statistics for Analytical Chemists	3	
SCI 511	Project Management	3	
SCI 522	Public Engagement for Scientists	3	
Select a minimum of two courses from the following:			4
PHYS 566	Environmental Health Physics	2	
PHYS 574	Introduction to the Nuclear Fuel Cycle	2	
PHYS 577	Operational Health Physics	2	
PHYS 578	Medical Health Physics	2	
Total Credit Hours			31

Master of Health Physics with Specialization in Radiochemistry

Required Courses			(24)
PHYS 561	Radiation Biophysics		3
PHYS 571	Radiation Physics		3
PHYS 573	Standards, Statutes and Regulations		3
PHYS 575	Case Studies in Health Physics		3
PHYS 580	Introduction to Radiochemistry		3
PHYS 581	Radiochemistry Laboratory		3
PHYS 582	Applications of Radiochemistry		3
PHYS 770	Instrumentation for Health Physics		3
Health Physics Elective			(2-3)
Select a minimum of one course from the following:			2-3
CHEM 509	Physical Methods of Characterization	3	
or PHYS 539	Physical Methods of Characterization		
CHEM 512	Spectroscopic Methods II	2	
PHYS 574	Introduction to the Nuclear Fuel Cycle	2	
Non-Radiochemistry Electives			(6)
Select a minimum of two courses from the following:			6
CHEM 513	Statistics for Analytical Chemists	3	
SCI 511	Project Management	3	
or INTM 511	Industrial Leadership		
SCI 522	Public Engagement for Scientists	3	

Minimum degree credits required: 32

Master of Science in Applied Physics

The Master of Science in Applied Physics is a rigorous graduate degree program designed specifically for the undergraduate engineering major. The traditional bachelor of science degree in engineering only requires about one year of university physics. This is not enough time to be exposed to the physics of the 20th century. This becomes a serious deficiency for those engineering students seeking careers in the nanotechnology industry or those pursuing advanced degrees in fields where a solid knowledge of physics is required. The fields of laser technology, optics, semi-conductors, nuclear energy, nanofabrication, and biotechnology all demand applied physics. Illinois Institute of Technology's Master of Science in Applied Physics is designed to provide the undergraduate engineering major with this fundamental knowledge of physics that they need for a successful career.

For students in the IIT-Paris double degree program, the program can be completed in one calendar year by taking classes in the fall, spring, and summer semesters. For students enrolled in undergraduate engineering on the university's Mies Campus, there is the option of earning a bachelor's in engineering and the Master of Science in Applied Physics in just five years.

A comprehensive examination is required for the degree.

Curriculum

Required Courses			(20)
PHYS 405	Fundamentals of Quantum Theory I		3
PHYS 406	Fundamentals of Quantum Theory II		3
PHYS 501	Methods of Theoretical Physics I		3
PHYS 505	Electromagnetic Theory		3
PHYS 508	Analytical Dynamics		3
PHYS 515	Statistical Mechanics		3
Select one of the following colloquia options:			2
Option 1			
PHYS 585	Physics Colloquium	1	
PHYS 585	Physics Colloquium	1	
Option 2			
PHYS 685	Physics Colloquium	0	

PHYS 685	Physics Colloquium	0	
PHYS 597	Reading and Special Problems	2	
Engineering or Physics Electives			(12)
Select four courses in consultation with an academic adviser.			12
Total Credit Hours			32

Master of Science in Physics

Curriculum

Comprehensive examination
Thesis and oral defense (optional)

For those interested in research, 7-9 credit hours of PHYS 591 or PHYS 691 may be applied to the 32 credit hour requirement.

Master of Science in Physics (Coursework Only Option)

Required Courses		(18-23)
PHYS 501	Methods of Theoretical Physics I	3
PHYS 505	Electromagnetic Theory	3
PHYS 508	Analytical Dynamics	3
PHYS 509	Quantum Theory I	3-6
or PHYS 405 & PHYS 406	Fundamentals of Quantum Theory I and Fundamentals of Quantum Theory II	
PHYS 510	Quantum Theory II	3
PHYS 515	Statistical Mechanics	3
PHYS 585	Physics Colloquium	0-1
or PHYS 685	Physics Colloquium	
PHYS 585	Physics Colloquium	0-1
or PHYS 685	Physics Colloquium	
Electives		(9-14)
Select 9 to 14 credit hours		9-14

Minimum degree credits required: 32

Master of Science in Physics (Thesis Option)

Required Courses		(18-23)
PHYS 501	Methods of Theoretical Physics I	3
PHYS 505	Electromagnetic Theory	3
PHYS 508	Analytical Dynamics	3
PHYS 509	Quantum Theory I	3-6
or PHYS 405	Fundamentals of Quantum Theory I	
or PHYS 406	Fundamentals of Quantum Theory II	
PHYS 510	Quantum Theory II	3
PHYS 515	Statistical Mechanics	3
PHYS 585	Physics Colloquium	0-1
or PHYS 685	Physics Colloquium	
PHYS 585	Physics Colloquium	0-1
or PHYS 685	Physics Colloquium	
Thesis Research		(7-9)
PHYS 591	Research and Thesis M.S.	7-9
or PHYS 691	Research and Thesis Ph.D.	
Electives		(0-7)
Select 0-7 credit hours		0-7

Minimum degree credits required: 32

Doctor of Philosophy in Physics

Curriculum

Written qualifying examination
Comprehensive examination
Dissertation and oral defense

The requirements for the degree consist of a program of 72 credit hours approved by the faculty adviser, passing the Ph.D. qualifying and comprehensive examinations, and the completion of a research thesis supervised by a faculty member and approved by a thesis committee. Students should consult the Transfer Credit section (p. 476) of this bulletin for rules on how many credit hours may be transferred from another institution.

Required Courses			(27-34)
PHYS 501	Methods of Theoretical Physics I		3
PHYS 505	Electromagnetic Theory		3
PHYS 508	Analytical Dynamics		3
PHYS 509	Quantum Theory I		3-6
or PHYS 405	Fundamentals of Quantum Theory I		
or PHYS 406	Fundamentals of Quantum Theory II		
PHYS 510	Quantum Theory II		3
PHYS 515	Statistical Mechanics		3
PHYS 585	Physics Colloquium (taken four times)		0-4
or PHYS 685	Physics Colloquium		
Select a minimum of three courses from the following:			9
PHYS 502	Methods of Theoretical Physics II	3	
PHYS 518	General Relativity	3	
PHYS 520	Bio-Nanotechnology	3	
PHYS 537	Solid State Physics I	3	
PHYS 538	Solid State Physics II	3	
PHYS 539	Physical Methods of Characterization	3	
PHYS 545	Particle Physics I	3	
PHYS 546	Particle Physics II	3	
PHYS 553	Quantum Field Theory	3	
PHYS 561	Radiation Biophysics	3	
PHYS 570	Introduction to Synchrotron Radiation	3	
Elective Courses			(2-21)
Select 2-21 credit hours [1]			2-21
Ph.D. Research			(24-36)
PHYS 691	Research and Thesis Ph.D.		24-36

Minimum degree credits required: 72

1 The remaining course requirements may be satisfied by additional graduate or advanced undergraduate electives.

Students are encouraged to participate in faculty research programs and seminars early in their graduate careers. Thesis work may follow from these activities. All research for the dissertation must be carried out under the direct supervision of a faculty research adviser.

Certificate in Radiological Physics

Curriculum

Elective courses			(12)
Select a minimum of four courses from the following:			12
PHYS 561	Radiation Biophysics	3	
PHYS 566	Environmental Health Physics	2	
PHYS 571	Radiation Physics	3	
PHYS 572	Introduction to Health Physics	3	
PHYS 573	Standards, Statutes and Regulations	3	
PHYS 574	Introduction to the Nuclear Fuel Cycle	2	
PHYS 575	Case Studies in Health Physics	3	
PHYS 576	Radiation Dosimetry	3	
PHYS 577	Operational Health Physics	2	
PHYS 578	Medical Health Physics	2	
PHYS 770	Instrumentation for Health Physics	3	
Total Credit Hours			12

Institute of Design

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Chicago, IL 60610
312.595.4900
design@id.iit.edu
id.iit.edu

Faculty with Research Interests
For more information regarding faculty visit the Institute of Design website.

A Legacy of Experimenting and Responding to Change

The Institute of Design has continuously explored emerging ideas about how design interacts with society. At its founding as the New Bauhaus in 1937, the faculty and students experimented with new visual languages and use of new media and material. The school was renamed the Institute of Design (ID) in 1944 and merged with Illinois Institute of Technology in 1949. In the mid-1950s, while the mainstream of design focused on visual embellishment of communications and products, ID faculty recognized design could be useful in the large-scale problems facing business and society and were the first to incorporate approaches from the social sciences with the design process. In the 1960s, two decades before it was common, ID pioneered the use of computers to support analysis and synthesis in design. In the late 1980s, ID faculty noticed an increasing need for organizations to link their strategy to a deeper understanding of people. Thus, ID created areas of study in strategic design planning and human-centered design to complement traditional specialties like communication design and product design. As design addressed larger problems and increased its influence in various parts of organizations, it became evident that design needed a more formal body of knowledge. To help increase the rigor and speed of the development of new theories and methods in design, and with the support of the GE Foundation, ID created the first Ph.D. program in design in the United States. Today, ID is focused on using design methods to address complex problems that confront organizations and society at large.

ID Today

Institute of Design attracts students and faculty from around the world who want to create and learn new design methods to address major challenges of organizations and society at large. The 200-person community of graduate students, full-time and adjunct faculty, staff, and visiting researchers are very diverse yet share a common goal.

The diversity at ID comes from the interesting people who join. Entering students, on average, have six years of professional experience in design or in other fields including the social sciences, engineering, business, and the arts. Some are recent graduates from the best universities in the world while others may have ten years of work experience or graduate degrees in a variety fields. About forty percent come from outside the United States. Twelve full-time and forty adjunct faculty members represent a phenomenal range of experiences from academic research to leadership within design firms and centers of innovation at large companies. Visiting researchers come from government agencies and other universities around the world, representing a variety of fields such as design, law, and business.

Those who join ID share the goal of using design methods to help define and solve challenges facing companies, governments, and civic organizations. They have noticed that standard ways to plan for next-generation products, messages, and services lack efficacy because the nature of business and the lives of users are more complex, ambiguous, and faster changing than before. They believe structured design methods can define and explore strategic options to make organizations more productive and improve the daily life of people.

ID Degree Programs

ID's programs are markedly different from other graduate design programs because we teach rigorous methods, focus on complex problems, and link strategy to a human-centered viewpoint.

The Master of Design (M.Des.) program is for students who want to achieve mastery of advanced design. Students can take a variety of classes to form one or more specialties. These include communication design, interaction design, product design, strategic planning, user research, design methods, and systems design. This full-time program has a two-year duration for those holding degrees in industrial or communication design and a three-year duration for those with degrees in other fields.

The M.Des./M.B.A. program allows a student to earn a Master of Business Administration degree (through Stuart School of Business) while concurrently earning the Master of Design degree.

The Master of Design Methods (M.D.M.) program is for mid-career professionals from a variety of backgrounds who want to augment their current abilities by learning advanced design methods. Students may have backgrounds from design or other fields and should have at least ten years of experience leading projects in either design or innovation. The M.D.M. can be earned full-time over two semesters or part-time over four to six semesters.

The Ph.D. program is for researchers who seek to contribute to theories and methods core to the field of design.

Faculty Research

Full-time and adjunct faculty represent specific areas of expertise critical to the field, like product design, communication design, information design, design planning, the history of design, interactive diagrams, cognitive psychology, anthropology, semantics of form, imaging, and computer science. The faculty at ID conducts various types of research supported by foundations, companies, government agencies, and individuals. In general, the research intends to add to the body of knowledge in design while at the same time demonstrates how design can be applied to a variety of problems that often seem extremely complicated or vexingly ambiguous. See id.iit.edu for more information.

Admission Requirements

Admission to all degree programs at ID is highly competitive. Meeting the minimum requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Master of Design

For admission to the Master of Design (M.Des.) and Master of Design/Master of Business Administration (M.Des./M.B.A.) programs, an applicant must hold a baccalaureate degree from an accredited educational institution with a minimum cumulative GPA of 3.0/4.0, have a strong record of academic achievement, and be highly recommended. Applicants should have a minimum of two years of professional experience. Applicants from countries whose native language is not English must submit scores for TOEFL (100 minimum) or IELTS (7.5 minimum). Portfolios are required for applicants who possess design degrees. Applicants without design degrees are encouraged to apply to the M.Des. program. All applicants without an undergraduate degree in industrial or communication design must submit GRE (310 minimum) or GMAT (600 minimum) scores. Regardless of previous degrees, students may be required to complete prerequisite design courses before starting their M.Des. requirements.

Master of Design Methods

In addition to the requirements for Master of Design, applicants to the Master of Design Methods program must have at least five years of professional experience (eight to ten years is typical) in leading teams creating novel, effective products, communications or services. A document or portfolio representing this work is required along with three letters of recommendation from professional colleagues. The quality of this professional work substitutes for GRE/GMAT test scores.

Doctor of Philosophy

Applicants to the Ph.D. program must hold a master's degree in design from an accredited educational institution, have a distinguished record of academic achievement, and be very highly recommended. Applicants without a master's degree should apply for the M.Des. program. Doctoral applicants with a master's degree in design must show evidence of distinguished academic and, if appropriate, professional work in their fields. Depending on the applicant's academic background and intended area of study, other prerequisite courses may also be required.

Degrees Offered

- Master of Design (p. 322)
- Master of Design Methods (p. 324)
- Doctor of Philosophy in Design (p. 326)

Dual Degree Program

- Master of Design/Master of Business Administration (with Business) (p. 325)

Course Descriptions

IDN 502
Making the User-Centered Case
Covers the rhetoric of design case making using verbal, quantitative, visual, and spatial modes of persuasion. Includes a survey of document and presentation types useful in the product development process.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 504
Introduction to Observing Users
This class will introduce students to theory and methods of behavioral observation, description, and analysis.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 506
Research Planning and Execution
This course examines research methods used throughout the design and development process from process, financial, and results standpoints with a focus on planning research activities.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 508
Principles and Methods of User Research
This course is a survey of the research methods commonly used in design research and gives an overview of distinctions between primary and secondary research, quantitative and qualitative research, and online and in-person research in order to prepare students for research-intensive projects.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 510
Research Photography
This course aims to give design researchers the knowledge and tools to consistently make the right decisions when capturing and selecting photographs to use in storytelling.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 512
Interview Methods
The focus of this course is to gain familiarity with an underlying set of the principles and practices of ethnographic interviewing.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 514
Experience Modeling
This course is intended to familiarize students with the methods and practice of experience modeling. It entails a deep understanding of people in naturalistic, everyday settings and interpretive methods of analysis to create representations of the organization of everyday life.
Lecture: 3 **Lab:** 0 **Credits:** 1.5,3

IDN 516
Cultural Probes
This course examines methods that aim to understand the cultural meaning that artifacts have to people.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 517
Stimlulus in Design Research
This course will introduce students to the whens and hows of creating and using stimulus effectively in their practice of design research.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDN 518
Survey Methods
This class aims to familiarize designers with the tools and techniques that are commonly used by quantitative researchers such as surveys and statistical analysis. Students will learn how to design, understand, and evaluate surveys and other quantitative research tools and techniques as well as how to use online survey tools in their own work.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 520
Co-Design and Participatory Research
This course will introduce students to co-design methods including when to use co-design methods, what are the advantages and disadvantages of co-design methods, and how to create engaging co-design workshops.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 522
Coding and Analysis
This course will allow students to gain rigorous training in how to develop coding schemes, code qualitative data, and gain a deeper analysis of users based on field research.
Prerequisite(s): [(IDN 504)]
Lecture: 0 **Lab:** 0 **Credits:** 1.5

IDN 526
Online Research Methods
This class covers methods and tools used in online research with a focus on the design of research objectives, implementation of their study protocol, and moderation of study participants.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 530
Introduction to Design Planning
Introduces students to the broad context of design planning. It includes a discussion of the general forces acting upon an organization (competition, technological developments, channels of information, and product distribution) and ways to understand the people who use design.
Lecture: 0 **Lab:** 0 **Credits:** 1.5,3

IDN 532
Business Frameworks and Strategy
A descriptive course in business strategy for designers covering new venture strategy, competitive strategy, marketing strategy and tactics, decision sciences, entrepreneurship, private equity, business plan writing, innovation, introductory finance, and self-discovery. This course will build a series of non-mathematical models of success and failure in both entrepreneurial and corporate settings.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 534
Business Models and Value Webs
This course will consider the relationship between theories and practice in the two very different realms of economics and design.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 535
Organizational Models of Innovation
This course will examine traditional and emerging models for how large organizations and other corporate entities engage to develop innovative offerings. Readings will cover recent developments in cooperative and open-sourced forms of innovation development.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDN 536
Introduction to Portfolio Planning
This course is an introduction to the techniques and processes involved in portfolio planning. We will explore the role of portfolio planning in typical organizations and how it relates to other processes like strategy and specific product development.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 537
New Venture Design
New Venture Design will teach aspiring entrepreneurs how to build design-led start-ups and new ventures, making this course ideal for students with new business ideas that they have been itching to design and launch. This exploration will happen across the four critical elements of a new venture: brand / value proposition; user experience; business model; and organization. Students will walk away with an understanding of how to architect new ventures using a combination of user empathy, market data, and intuition.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDN 538
Design Planning Workshop
This course covers the application of design planning methods and theory to real-world challenges. With a team-based, hands-on approach, students will tackle all stages of problem solving from initial framing to final solution proposals. Students may take this class multiple times, non-concurrently, for a maximum of 12 credits towards their degree.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 539
Social and Economic Context of Design
This course examines the broader issues and forces that affect the conditions of how design can be effective within typical organizations. Through exercises and application of frameworks to examine these forces, students learn to recognize and adapt design plans to changing contexts.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 540
Planning Implementation
Introduces frameworks and methods for effectively implementing change in organizations. Using cases, students will identify principles, actions, and measures that mitigate risk, improve implementation success, and inform stronger designs.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 542
Behavioral Economics
This course will introduce how concepts from the field of behavioral economics can be thought of as another kind of "human factor" and ways in which they can help inform the process of design thinking.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 543
Communication Strategies
This class introduces students to key concepts and methods to communicate design work. This includes a conceptual shift from communication as transmission of content to collaborative construction to better engage and align stakeholders in design work.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 544
Diagram Development
Explores the language of diagrams as a communication means to represent different types of abstract, relational information. Students will be introduced to design principles of developing effective diagrams and multiple types of diagrams.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 546
Metaphor and Analogy in Design
This class explores metaphor for its utility as a powerful thinking and communication tool drawing from research in academic fields such as cognitive linguistics and visual communications. Students will consider metaphors and analogies (as well as similes, allegories, metonymies, and other visual/verbal devices) for their power open up new thinking, frame change and suggest action -- all critical communication milestones in design planning.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 548
Advanced Diagramming
This class focuses on the study and development of visualizations to expand information presentation by using dynamic, interactive properties. Explorations to include data narratives, data visualization, time-based visualizations, analyzing motion, narration, transitions, and other visual properties that can enhance comprehension.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 550
Communication Design Workshop
A project-oriented workshop focusing on applying design principles to link theoretical methods to practice in the area of human-centered communication design. Students may take this class multiple times, non-concurrently, for a maximum of 12 credits towards their degree.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 552
Fundamentals of Visual Communication
Discusses pictures, abstract symbols, text, numbers, diagrams, three-dimensional form, and other sign systems in the context of communicating a designed offering. Additional teachings include the basics of visual communication principles to aid in developing effective communications.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 554
Theories of Communication
This class introduces students to theories of communication from other academic fields for application in design. It explores broadly the conception of communication to include relevant perspectives from education, social psychology, phenomenology and knowledge management.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 556
Communication in the Planning Process
This class teaches students how to use communication as a design method to accelerate synthesis and give tangible form to valuable information throughout the development process. Students are introduced to relevant theories of language, visual perception, visual representation, and communication.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 562
Modeling Complexity
How does one visually capture and represent complex systems, topics, and activities that are too large to conceptualize using memory and cognition alone? Modeling complexity is a visual approach to large-scale problem definition that seeks to represent the full picture of a system by applying theories of visual perception and known techniques for representing relationships in data.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 564
Information Structuring and Management
The class introduces the basic principles and methods for structuring complex information for effective understanding, identifying problems, and guiding solution development. Graph theory, definitions of relations, and structural patterns of relations are introduced as foundation. Examples of information structuring and management include basics of Structured Planning, Semantic Net, and Interpretive Structural Modeling.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 566
Systems Approach to Design
The primary goal of the course is to understand systems thinking and approaches in design. The course reviews historical development of systems approaches and introduces systems concepts and approach to design. Particular emphasis goes to system modeling methods that facilitate designers to observe, describe, analyze, predict/envision, design, prototype, and evaluate behavior and performance of complex systems from different viewpoints.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 568
Service Systems Workshop
This workshop introduces concepts of services, design principles, and methods that are needed for the design of service systems. Topics include the nature of services, customer acquisition and retention, value propositions in service business, service prototyping and pilot testing, stakeholder management, infrastructure, and operational and implementation issues. Students may take this class multiple times, non-concurrently, for a maximum of 12 credits towards their degree.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 570
Structured Planning Workshop
Introduces structured planning methodology and applies it to complex design problems at the system level. Team techniques are emphasized, and formatted information handling and computer-supported structuring processes are used through the design process from project definition to information development, structuring, concept development, and communication. Students may take this class multiple times, non-concurrently, for a maximum of 12 credits towards their degree.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 571
Systems and Systems Theory in Design
The course investigates principles and methods for representing and understanding structure and behavior of different types of systems. Various forms of theoretical and philosophical frameworks and methodologies are introduced to model and understand fundamental characteristics of domains of concern from different perspectives. Class topics include general systems theory, system modeling, causality, and formalisms. The class will also explore example applications of system concepts and modeling methods in design research.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDN 572
Platform-Based Design Strategy
Platform is an innovation strategy that provides a common set of standards to enable a variety of offerings to be built on top of it, creating higher value for all stakeholders involved. This course explores how platforms provide a base to accommodate many options that can support diverse contexts and user needs.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 573
Sustainable Solutions Workshop
In this course students will learn how to apply design methods and strategic thinking through open innovation practices for leveraging the interconnectivity of markets, technology, finance, and social networks in order to envision sustainable solutions with impact in the local lives and well-being of communities.
Lecture: 3 **Lab:** 0 **Credits:** 3

IDN 574
Design Process and Knowledge
Introduces basics of design methodologies concerning design process models and knowledge representation and management. It discusses multiple viewpoints and aspects of design in order to address complexity of information required to implement human-centered approaches and interdisciplinary collaboration as well as developing and managing effective design processes, methods, and organizations for enabling innovative design.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDN 575
Sustainable Systems Seminar
In this course students will learn key principles and concepts on complex adaptive systems in relation to human-centered design for understanding how product and service innovation can shape sustainable value webs and marketplaces.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDN 576
Systems Modeling and Prototyping
This workshop class introduces system modeling methods for representing different types and aspects of systems including continuous models, discrete models, probabilistic models, and structural models. System modeling and simulation software packages are used to understand and predict the system behavior. Various forms of physical prototyping are also applied as complementary methods to understand, analyze, explore, and evaluate systems through the development process.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDN 578
Human System Integration
This course teaches students the principles of socio-technical system design. Today's complex systems need to be designed as a whole system rather than piece-meal components. Hence, this course introduces students to the perspectives and principles that can be used when designing complex systems with people and technical subsystems.
Lecture: 3 **Lab:** 0 **Credits:** 3

IDN 685
Ph. D. Principles and Methods of Design Research
Introduces the basic principles and methods for assembling, developing, and analyzing information in the tasks of design research. Techniques for collecting data, testing hypotheses, and presenting conclusions are learned in the context of conducting a pilot research project.
Lecture: 0 **Lab:** 0 **Credits:** 1.5

IDN 687
Ph. D. Philosophical Context of Design Research
Explores the philosophical framework for conducting research and building knowledge in the field of design. Topics include concepts from epistemology, phenomology, and structuralism. Comparisons are made between design research and research in other fields.
Lecture: 0 **Lab:** 0 **Credits:** 1.5

IDN 689
Ph.D. Research Seminar
Investigation and discussion by faculty and students of topics of interest from different perspectives such as building a design research discourse (reading research papers critically, selecting among publication venues); investigating alternative philosophical bases for design research (comparing empirical, pragmatic, and phenomenological approaches); or exploring methodological and theoretical conflicts in design research.
Lecture: 3 **Lab:** 0 **Credits:** 3

IDN 691
Research and Thesis for Ph. D. Degree
Research and thesis writing.
Credit: Variable

IDX 502
New Product Definition
This course introduces students to the professional and theoretical aspects of the product definition process. It covers the process of creating a new product definition in detail, the characteristics of new product definition documents, aspects of organizational structure and dynamics as they relate to developing new product definitions, and sources of innovation.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 503
Design Connoisseurship
Design Connoisseurship introduces design as a profession in context with history and contemporary practice. Multiple perspectives including the human-centered design process, the role of the senses, an appreciation of craftsmanship, and importance of stakeholders will be introduced with methods to assess and solve complex problems. Emphasis will be placed on learning how to articulate issues and define success or failure.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDX 504
Prototyping Methods
Prototyping is a key method that designers use to navigate the design development process. Although prototyping is often thought of as coming at the end of the process to verify a design solution, our approach maintains that prototyping needs to happen throughout the process from initial research to storytelling to concept generation and lastly to refine and improve the selected direction.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 506
Form and Materials
In this course students will examine what, how, and why product form happens. Topics include the relationship between a product's form and corporate identity, visual trends, new materials, manufacturing techniques, semantics, product architecture, and ergonomics.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 508
Modes of Human Experience
Analysis of issues involved in a design project with a human factors perspective is an important step during user research and the design development process. Knowing the basic concepts and principles of human factors will enable students to be user centered in their approach.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 510
Design Development and Implementation
An introduction to the common methods used to produce or manufacture products. Alternative processes, materials and finishing methods, relative costs, and applicability to design of products will be explored.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 512
Product Design Workshop
This course is an opportunity for students to exercise their design muscles throughout an entire product development experience from framing through ideation to final concepts. Students may take this class multiple times, non-concurrently, for a maximum of 12 credits towards their degree.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 514
Product Architecture and Platforms
This course introduces the concept of product architecture and platform to explore their possible applications to different types of products from different viewpoints.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 518
Interaction Design Methods
This course introduces methods for effectively describing the dynamic nature of interaction and applies them to different types of design cases.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 520
History of Interaction Design
This course examines thought leaders in interaction design, their innovations, and the technology and business contexts that shaped the environment for their work. Students will review designs to better understand the elements that led to significant design breakthroughs.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 522
Persuasive Interaction Design
This course examines interactive media and focuses on design methods and techniques for improved engagement between the entity providing the offering (e.g., product or service provider) and the entity consuming the offering (e.g., users, stakeholders, and purchasers).
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 524
Interaction Design Workshop
This workshop offers students the opportunity to practice methods for design research, concept development, interaction design, and rapid prototyping.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 526
Digital Development Workshop
This course introduces different tools and platforms for the development of interactive systems. Students will employ the different platforms to translate a concept from concept to prototypes for evaluation and communication. Students may take this class multiple times, non-concurrently, for a maximum of 12 credits towards their degree.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 528
Prototyping Interactions
This course introduces different methods and tools for the prototyping of interactive systems. Students will employ the different methods to translate a concept from ideation to installation through multiple layers of sketches, prototypes, and interactive peripherals.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 530
Interaction Design for Immersive Systems
This course explores issues in design for interactions that are enabled by affordances available in ubiquitous computing, mixed reality, and virtual reality environments.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 532
Interaction Design for Embedded Systems
This course explores interaction design principles, opportunities, and issues for embedded systems. It includes evaluating and creating product concepts for vertical markets and various levels of computing performance, modalities, affordances, and constraints.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 533
Engaging Stakeholders in Innovation
This course focuses on the social dynamics of design as an agent of change and innovation introducing students to simple frameworks to help them get ideas off the ground and gain support within their organizations. The course will explore cognitive models and simple methods to engage key stakeholders and facilitate organizational buy-in.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

IDX 534
Interactive Space
This seminar will look at different variations of interactive and reactive spaces. The seminar will concentrate on the theory and construction of, identities and characteristics of actors embedded in, and the technology employed in the design of such spaces.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 536
Extensions of Media and Technology
This seminar is designed to engage students in a critical discussion about contemporary media and technology and the socio-cultural contexts in which they are situated. Theoretical notions as well as contemporary critique of media, technology, and their appropriations will be explored through lecture and discussion sessions.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

IDX 538
Networked Cities
This course will explore the relationship between technologies -- new media, urban screens, mobile and wireless technology, and ubiquitous computing -- and cities and urban public spaces.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 540
Networked Objects
This workshop will explore the relationship between digital technologies -- new media, urban screens, sensors and radio-frequency identification chips (RFID), mobile and wireless technology, and ubiquitous computing -- as they are embedded into physical products/artifacts, spaces, and environments as well as architecture and buildings, which is commonly referred to as the "internet of things."
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 542
Analysis + Synthesis in Design
This course is an overview of methods to analyze data and synthesize solutions that will likely be encountered as part of a design effort.
Lecture: 3 **Lab:** 0 **Credits:** 3

IDX 548
Innovation Methods
The course will present an overview of some of the key principles that drive design innovation followed by a broad look at the design innovation process, various methods, and frameworks.
Lecture: 3 **Lab:** 0 **Credits:** 1.5,3

IDX 550
Building and Understanding Context
This course will improve critical thinking skills when wrestling with the wide variety of input and insight that often accompanies design initiatives. The course will include basic overviews of argumentation, secondary research, and group-based discussion methods.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 552
Managing Interdisciplinary Teams
This class will teach methods and tools that focus a team's creativity and analysis on the right deliverables and explore how the basic functional methods of the business world (such as schedules, budgets, emails, and meetings) can be informed by design thinking to be more effective for teams composed of multiple disciplines.
Lecture: 0 **Lab:** 0 **Credits:** 3

IDX 560
Analysis + Synthesis for Non-Designers
A course to introduce the techniques and process of problem definition and solution generation as used in the field of design.
Lecture: 2 **Lab:** 0 **Credits:** 3

IDX 562
Multidisciplinary Prototyping for Entrepreneurs
Prototyping for non-designers.
Lecture: 3 **Lab:** 0 **Credits:** 3

IDX 594
Faculty Research
Classes, workshops, and seminars revolving around faculty specific research. Instructor permit only. Instructor will define requirements for enrollment. Students may take this class multiple times for a maximum of 24 credits toward their degree.
Credit: Variable

IDX 595
Internship
Supervision of participation in curricular practical training (CPT).
Lecture: 0 **Lab:** 0 **Credits:** 0

IDX 597
Special Topics
Classes that cover special and contemporary topics in design. Students may take this class multiple times for a total of 24 credits toward their degree.
Credit: Variable

Master of Design

The Master of Design (M.Des.) program is a two-year, 54 credit-hour degree program intended for those seeking professional mastery at the highest level in the field. The program does not require the formal selection of a concentration area or a final thesis project. Students may construct their own curriculum after taking a core of methods courses focused on understanding users, analyzing complex information, and exploring and prototyping alternative solutions. Examples of individual courses of study include communication design, interaction design, product design, strategic planning, user research, design methods research, and systems design.

Residence

The M.Des. program requires continuous full-time study at the Institute of Design for a minimum of four semesters. Students must enroll in at least 13.5 credit hours of coursework each semester.

Curriculum

Minimum Degree Credits	54
Minimum Degree Credits with Foundation Courses	84

Required Courses			(15)
IDN 504	Introduction to Observing Users		3
IDN 530	Introduction to Design Planning		1.5
IDN 556	Communication in the Planning Process		1.5
IDX 504	Prototyping Methods		1.5
IDX 508	Modes of Human Experience		1.5
IDX 542	Analysis + Synthesis in Design		3
IDX 550	Building and Understanding Context		3
Foundation Courses			(0)
These courses are prerequisite for students without an undergraduate degree in industrial or communication design and must be completed prior to proceeding with any other M.Des. requirements.			
IDN 481	Introduction to Design I	3	
IDN 482	Introduction to Design II	3	
IDN 483	Introduction to Communication Design I	4	
IDN 484	Introduction to Communication Design II	4	
IDN 485	Introduction to Product Design I	4	
IDN 486	Introduction to Product Design II	4	
IDN 487	Introduction to Photography	4	
IDN 488	Introduction to Digital Media	4	
ESP + Design Courses			(0)
These courses are co-requisite for students who require additional fluency in English and design-specific vocabulary.			
IDN 461	Design Reading and Writing Skills I	3	
IDN 462	Design Listening and Presentations Skills	3	
IDN 463	Cross-Cultural Communication I	2	
IDN 464	Cross-Cultural Communication I Laboratory	1	
IDN 466	Design Reading and Writing Skills II	3	
IDN 467	Design Listening and Presentation II	3	
IDN 468	Cross-Cultural Communication II	2	
IDN 469	Cross-Cultural Communication II Laboratory	1	
Elective Courses			(39)
Select 39 credit hours. See elective course options below. [1]			39
Total Credit Hours			54

[1]Elective Courses

Students select a series of courses to meet the objectives of the student's professional goals. Choices will be made in consultation with the student's adviser and will count for at least 39 credit hours of the required program. Up to 6.0 credits may be taken outside of ID with the approval of the student's adviser. See the list below.

IDN 502	Making the User-Centered Case	1.5
IDN 506	Research Planning and Execution	1.5
IDN 508	Principles and Methods of User Research	3
IDN 510	Research Photography	1.5
IDN 512	Interview Methods	1.5
IDN 514	Experience Modeling	3
IDN 516	Cultural Probes	1.5
IDN 517	Stimlulus in Design Research	1.5
IDN 518	Survey Methods	1.5
IDN 520	Co-Design and Participatory Research	1.5
IDN 522	Coding and Analysis	1.5
IDN 526	Online Research Methods	1.5
IDN 532	Business Frameworks and Strategy	1.5
IDN 534	Business Models and Value Webs	1.5
IDN 536	Introduction to Portfolio Planning	1.5
IDN 537	New Venture Design	1.5
IDN 538	Design Planning Workshop	3
IDN 539	Social and Economic Context of Design	1.5
IDN 540	Planning Implementation	1.5
IDN 542	Behavioral Economics	1.5
IDN 543	Communication Strategies	1.5
IDN 544	Diagram Development	1.5
IDN 546	Metaphor and Analogy in Design	1.5
IDN 548	Advanced Diagramming	1.5
IDN 550	Communication Design Workshop	3
IDN 552	Fundamentals of Visual Communication	1.5
IDN 554	Theories of Communication	1.5
IDN 562	Modeling Complexity	1.5
IDN 564	Information Structuring and Management	1.5
IDN 566	Systems Approach to Design	1.5
IDN 568	Service Systems Workshop	3
IDN 570	Structured Planning Workshop	3
IDN 571	Systems and Systems Theory in Design	1.5
IDN 572	Platform-Based Design Strategy	1.5
IDN 574	Design Process and Knowledge	1.5
IDN 576	Systems Modeling and Prototyping	3
IDN 578	Human System Integration	3
IDX 502	New Product Definition	3
IDX 506	Form and Materials	1.5
IDX 510	Design Development and Implementation	1.5
IDX 512	Product Design Workshop	3
IDX 514	Product Architecture and Platforms	1.5
IDX 518	Interaction Design Methods	1.5
IDX 520	History of Interaction Design	1.5
IDX 522	Persuasive Interaction Design	1.5
IDX 524	Interaction Design Workshop	3
IDX 526	Digital Development Workshop	3
IDX 528	Prototyping Interactions	3

IDX 530	Interaction Design for Immersive Systems	1.5
IDX 532	Interaction Design for Embedded Systems	1.5
IDX 533	Engaging Stakeholders in Innovation	1.5
IDX 534	Interactive Space	1.5
IDX 536	Extensions of Media and Technology	1.5
IDX 538	Networked Cities	3
IDX 540	Networked Objects	3
IDX 548	Innovation Methods	3
IDX 552	Managing Interdisciplinary Teams	3
IDX 560	Analysis + Synthesis for Non-Designers	3
IDX 562	Multidisciplinary Prototyping for Entrepreneurs	3
IDX 594	Faculty Research	1-10
IDX 597	Special Topics	1.5-10

Master of Design Methods

The Master of Design Methods (M.D.M.) is a nine-month full-time (or four to six semesters part-time) executive master's degree for exceptional design, management, engineering, and other professionals who wish to acquire robust design methods and frameworks and apply them to the development of products, communications, services, and systems. M.D.M. courses cover design methods and frameworks in areas such as user observation and research; prototyping of new services, products and businesses; creating systems of innovation; visualizing alternative futures; and linking user innovation to organizational strategy.

Residence

The M.D.M. can be taken in two semesters (full-time) with a minimum of 15 credit hours each semester or over four to six semesters (part-time), with a minimum of 3 credit hours each semester.

Curriculum

Required Courses		(9)
IDN 504	Introduction to Observing Users	3
IDN 530	Introduction to Design Planning	1.5
IDX 508	Modes of Human Experience	1.5
IDX 542	Analysis + Synthesis in Design	3
Elective Courses		(21)
Select 21 credit hours [1]		21
Total Credit Hours		30

1 Students select a series of courses from the available studios and lectures to meet the objectives of the student's professional goals. Choices will be made in consultation with the student's adviser and will count for at least 21 credit hours of the program. Students select from the same pool of elective classes as found under the Master of Design (p. 322) description.

Master of Design/Master of Business Administration

Curriculum

44 Institute of Design credit hours
36 Stuart School of Business credit hours

The program director or academic adviser will develop a curriculum plan when the student begins the dual-degree program. Students select a series of courses from the available studios and lectures to meet the objectives of the student's professional goals. Students select from the same pool of elective classes as found under the Master of Design (p. 322) description.

Typically, students will reduce the overall credit requirements of typical individual degree programs because M.B.A. will double count 6 M.Des. credit hours towards general electives and 6 credit hours towards the design leadership concentration, and M.Des. will double count 12 M.B.A. credit hours towards M.Des. electives. The program director may make exceptions to this plan depending upon the student's individual situation.

Required Courses		(48)
Institute of Design courses		
IDN 504	Introduction to Observing Users	3
IDN 530	Introduction to Design Planning	1.5
IDN 556	Communication in the Planning Process	1.5
IDX 504	Prototyping Methods	1.5
IDX 508	Modes of Human Experience	1.5
IDX 542	Analysis + Synthesis in Design	3
IDX 550	Building and Understanding Context	3
Stuart School of Business courses		
BUS 510	Building an Innovative and Sustainable Business	3
BUS 550	Business Analytics for Competitive Advantage	3
BUS 590	Business Innovation in the Next Economy	3
MBA 501	Accounting for Strategic Decision-Making	3
MBA 502	Emerging Issues in the Global Business Environment	3
MBA 504	Analytics for Decision Making	3
MBA 505	Contemporary Economic Analysis and Game Theory	3
MBA 506	Leadership in Knowledge-Intensive Organizations	3
MBA 509	Financial Management in a Globalized World	3
MBA 511	Creating, Communicating, and Delivering Customer Value	3
MBA 513	Operations and Technology Management	3
Elective Courses		(32)
Select 29 credit hours from Institute of Design		29
Select 3 credit hours from Stuart School of Business		3
Total Credit Hours		80

Doctor of Philosophy in Design

The Ph.D. in Design at the Institute of Design is an exemplary program of coursework and academic research in an international environment for supporting top candidates in the field. We have an outstanding record of achievement by our alumni, many of who are engaged at the highest levels of research and teaching. The Ph.D. leads to a dissertation that will extend the body of knowledge in design theory and process.

Requirements

The Ph.D. candidate must have a master's degree in an area relevant to design. The program requires a minimum of three years of study beyond the master's degree. For the first four semesters, students must be enrolled at a minimum of 12 credit hours at the Institute of Design. Satisfactory reading knowledge of German, Japanese, French, or Russian must be met before the student applies to take the comprehensive examination.

Schedule

The program begins with three or four semesters primarily of coursework with some research credit hours, followed by a qualifying exam based on the courses. After passing the qualifying exam, the student continues to work on a research proposal that demonstrates sufficient understanding of the research area, a novel significant concept as a basis for Ph.D. research, and well-organized research methods and processes. A Ph.D. examination committee will then be formed to approve the proposal during the comprehensive exam. Upon completion of the dissertation, the Ph.D. candidate will present the research results to the examination committee for the degree to be granted by the university.

Curriculum

Total: 107 credit hours
Coursework: 59 credit hours (including maximum 32 credit hours transferrable from master's program)
Language examination
Comprehensive examination
Dissertation research: 48 credit hours

Research

48 credit hours
The research component starts small and grows as the student progresses through his or her candidacy. The dissertation created from this work is intended to create a substantial and original contribution to design knowledge. Typically, 12 credit hours are earned over the first three terms; the remainder is earned over, at minimum, three additional terms.

Coursework

59 credit hours
Coursework includes credit hours transferable from the master's program. The maximum credit hours transferrable is 32. Classes include full- or half-semester courses selected from the university's course offerings to complement objectives of the student's program. They include 15 credit hours of required courses and 12 credit hours of elective courses as determined by the adviser. Most coursework credits are earned within the first three terms of enrollment.

Required Courses		(15)
IDN 571	Systems and Systems Theory in Design	1.5
IDN 574	Design Process and Knowledge	1.5
IDN 685	Ph. D. Principles and Methods of Design Research	1.5
IDN 687	Ph. D. Philosophical Context of Design Research	1.5
IDN 689	Ph.D. Research Seminar (taken twice)	6
PSYC 545	Graduate Statistics I (or equivalent)	3
Elective Courses		(44)
Select 44 credit hours		44
Ph.D. Research		(48)
IDN 691	Research and Thesis for Ph. D. Degree	48
Total Credit Hours		107

Lewis College of Human Sciences

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Technology is playing an increasingly large role in shaping how we look at our world—what we do and how we do it. In the Lewis College of Human Sciences, we work at the intersection of people and technology, exploring and explaining what is happening as technology reshapes the real and virtual places where we live, work, and play.

Established in 2013, Lewis College offers bachelor's, master's, and doctoral degrees in the Department of Humanities and Department of Psychology, and bachelor's degrees in the Department of Social Sciences. Our undergraduate and graduate programs are designed to emphasize the free spirit and broad perspectives traditionally reserved for the liberal arts, while fostering the development of valuable skills such as scientific thinking, technical research, data analysis, and digital communications. Lewis College students also gain practical experience alongside faculty who are dedicated to bridging the gap between theory and application, ideas and action.

Humanities

Degree Programs

- Master of Science in Technical Communication and Information Architecture (p. 336)
- Master of Science in Technology and Humanities (p. 337)
- Doctor of Philosophy in Technology and Humanities (p. 338)

Certificates

- Instructional Design (p. 341)
- Technical Communication (p. 341)

Psychology

Degree Programs

- Master of Science in Personnel and Human Resource Development (p. 352)
- Master of Science in Psychology (p. 353)
- Master of Science in Rehabilitation and Mental Health Counseling (p. 354)
- Master of Science in Rehabilitation and Mental Health Counseling with Advanced Standing (p. 355)
- Doctor of Philosophy in Psychology with Specialization in Clinical Psychology (p. 356)
- Doctor of Philosophy in Psychology with Specialization in Industrial/Organizational Psychology (p. 357)
- Doctor of Philosophy in Psychology with Specialization in Rehabilitation Counseling Education (p. 358)

Combined Degree Programs

- Bachelor of Science in Psychology/Master of Science in Personnel and Human Resources Development (p. 352)

Certificates

- Psychiatric Rehabilitation (p. 360)
- Rehabilitation Counseling (p. 360)
- Rehabilitation Engineering Technology (p. 360)

Humanities

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Chair
Margaret Power

Director, Graduate Studies
Libby Hemphill

Faculty with Research Interests
For more information regarding faculty visit the Department of Humanities website.

The graduate program in technology and humanities at Illinois Institute of Technology prepares students to make meaningful impacts on society through careers both inside and outside academia. Our graduates work as post-secondary faculty and in senior positions in business, government, and cultural institutions. Our students work closely with one or more faculty advisers to develop expertise in research and production in digital humanities. With programmatic roots in technical communication and a growing faculty in diverse areas broadly representative of the digital humanities, the graduate program in technology and humanities produces graduates who are skilled communicators as well as agile, innovative members and leaders of twenty-first century private, public, and academic workplaces.

Research Facilities

The department supports a number of research labs including:

- Humanities and Technology Lab (HaT Lab), with resources for conducting digital humanities research and teaching projects
- Collective Action and Social Media Lab (CASM Lab), conducting computational analysis of big social data
- Gewgaws Lab, a physical and virtual design production lab focused on open source
- Speech Analysis Lab, for applied research on natural and synthesized speech

The department also supports an editing center, Edit IIT, and writing center. Illinois Institute of Technology's Galvin Library subscribes to more than 120 electronic databases with more than 25,000 full-text journals and is part of CARLI, which through I-Share provides access to more than 32 million items across Illinois academic library collections. Students have access to computer labs across the university campus, some of which also serve as classrooms for graduate courses.

Research Areas

Humanities department faculty conduct research in a wide range of areas. Among those especially relevant to technology and humanities are civic impacts of social media; digital design and production; ethics and technology; games and gaming; gender and sexuality in technology; history of technology; science, technology, and society; and speech and text analysis.

Admission Guidelines - Certificate Programs

Applicants must have a four-year bachelor's degree from an accredited institution with a minimum cumulative GPA of at least 2.5/4.0 and must be admitted as a graduate certificate student. Certificate students who later apply to one of the department's M.S. programs or the Ph.D. program must meet the admission guidelines for that program. All coursework taken toward a certificate in technical communication or in instructional design and passed with a grade of "B" or better may also be applied to the M.S. in Technology and Humanities, the M.S. in Technical Communication and Information Architecture, or the Ph.D. in Technology and Humanities (for students who are admitted to one of those programs), as long as those courses were not applied to another degree. However, no more than 9 credit hours of 400-level coursework may be counted toward a degree program.

Admission Guidelines - Master's Degrees

Applicants to the master's program come from a variety of backgrounds. Some students enter with strong writing or design ability and learn to apply those skills in technical and scientific areas, while other students enter with a technical or scientific background and learn to enhance their communication skills. The program's goal is to help students build upon existing strengths and develop new areas of expertise.

Applicants must have a bachelor's degree from an accredited four-year institution, with a minimum cumulative GPA of 3.0/4.0.

In addition to the application form, the applicant must submit the following:

1. Professional statement discussing the applicant's academic or professional goals and plans for graduate study
2. Two letters of recommendation from faculty or supervisors who can evaluate the applicant's potential for graduate-level work
3. Official transcripts, or certified copies thereof, of all academic work at the college-level or above
4. Required test scores

All applicants are required to submit Graduate Record Exam (GRE) scores with a minimum combined score of 1000 (quantitative + verbal) with a minimum score of 500 in each area, and 3.0 (analytical writing). Students taking the revised GRE (2012 and later) must have a minimum scores of 144 in quantitative reasoning and 153 in verbal reasoning, and an analytical writing score of at least 4.0.

International students must submit TOEFL scores unless they are exempt as specified in the International Applicant Requirements (p. 14) section of this bulletin. The minimum TOEFL score is 95, with minimum section scores of 20 each in the listening, reading, and writing sections. Students submitting IELTS scores must have a minimum score of 7.0.

Note: Enrolling in courses does not guarantee later acceptance into a degree program, nor does meeting the minimum admission requirements. Students who enter as non-degree or certificate students should first discuss their plans with one of the co-directors of graduate studies.

Admission Guidelines - Ph.D. Program

Students enter the Ph.D. program from a wide range of fields, but should have substantial academic preparation or professional experience related to one or more humanities fields. Applicants must have completed a bachelor's or master's degree in a field that, in combination with the 30 credit hour technical core, would provide a solid basis for advanced academic work leading to original research in technology and humanities.

In addition to the application form, the applicant must submit the following:

1. A short (two pages) research statement
2. Writing or production sample
3. Three letters of recommendation
4. Official transcripts, or certified copies thereof, of all academic work at the college-level or above
5. GRE scores
6.TOEFL or IELTS scores (if applicable)

The research statement should articulate the applicant's research interests including what the applicant is interested in studying and why, who the applicant may be interesting in studying with, and how the applicant's prior education and/or experience has provided reasonable training in the particular field of interest.

Applicants submitting writing samples should choose a sample that demonstrates the applicant's analytical abilities and is in the applicant's declared field of interest. The sample should include a works cited list that enables the admissions committee to evaluate the applicant's familiarity with a field. Applicants submitting production samples or portfolios should submit materials that demonstrate their existing production skills and practice.

All applicants are required to submit Graduate Record Exam (GRE) scores with a minimum combined score of 1000 (quantitative + verbal), with a minimum score of 500 in each area, and 3.0 (analytical writing). Students taking the revised GRE (2012 and later) must have a minimum scores of 144 in quantitative reasoning and 153 in verbal reasoning, and an analytical writing score of at least 4.0.

International students must submit TOEFL scores unless they are exempt as specified in the International Applicant Requirements section (p. 14) of this bulletin. The minimum TOEFL score is 95, with minimum section scores of 20 each in the listening, reading, and writing sections. Students submitting IELTS scores must have a minimum score of 7.0.

Note: Enrolling in courses does not guarantee later acceptance into a degree program, nor does meeting the minimum admission requirements. Students who enter as non-degree or certificate students should first discuss their plans with one of the co-directors of graduate studies.

Degrees Offered

Certificate Programs

Course Descriptions

COM 501
Introduction to Linguistics
An introduction to the systematic study of language. Focus on the core areas of linguistics such as sound patterns of language (phonology), form (syntax, morphology), and meaning (semantics, pragmatics) as well as applied areas such as language variation, language, acquisition, psychology of language, and the origin of language.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 503
Analyzing and Communicating Quantitative Data
An introduction to statistics and data analysis tailored to the needs of communication and information professionals. Emphasis is placed on developing intuition as to which analyses are appropriate given one's questions of interest as well as how to interpret and communicate the results of analyses. Students will analyze real data sets using SPSS in the computer lab.
Lecture: 0 **Lab:** 0 **Credits:** 3

COM 506
World Englishes
Analysis of the variations of the English language throughout geographic and cultural regions of the world.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 508
Structure of Modern English
Analysis of English grammar from four major perspectives: prescriptive, descriptive, transformational-generative, and contextual perspectives. Different methods for analyzing sentences, ways of applying each method to problems in editing and writing, and contributions of linguists such as Noam Chomsky. While focusing on sentence structure, students also look at the structure of words (morphology)and larger units of text (discourse) at various points in the semester.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 509
History of the English Language
Study of the origins and development of key features of the English language through its important stages, including Old, Middle, and Early Modern English.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 510
The Human Voice: Description, Analysis, and Application
Analysis of human and synthetic speech intended for technology mediated environments and devices. Focs on talker characteristics that affect speech intelligibility and social factors that affect talker characteristics. Attention to design characteristics of technology mediated speech and how humans react to it.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 511
Linguistics for Technical Communication
This course examines linguistic theory as it relates to everyday problems. The course is divided into four sections, each of which expose students to an application of these topics to broader issues. Topics include sound patterns of speech, sentence structure, meaning and language and society.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 515
Discourse Analysis
Analysis of spoken and written texts on the intersentential and metalinguistic levels (e.g. semantic roles; given-new information; deixis and anaphora; presupposition and entailment; direct and indirect speech acts; schema theory). Applications to social and professional issues such as intercultural communication; sociopolitical discourse; discourse in educational, legal, and medical settings; narratives and literary texts.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 521
Theory in Technology and Humanities
Broad coverage of concepts and issues in current and classic scholarship in the field of technical communication. Intensive work in bibliographic research methods for academic genres.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 523
Communicating Science
This course focuses on strategies for communicating scientific information in professional settings. Students develop a literature review, proposal, and feasibility study; learn how to adapt scientific information to various audiences; and complete exercises on style, grammar, and other elements of effective professional communication. Emphasis on usability, cohesion, and style in each assignment.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 525
User Experience Research and Evaluation
An introduction to principles of user-centered design and to methods for conducting user experience research. Students will learn how to plan and conduct projects that evaluate the design, interface, and experience of a product or service. Course work includes designing studies, collecting and interpreting data, and reporting findings and recommendations from the perspective of user-centered design.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 528
Document Design
Principles and strategies for effective document and information design focusing on print media and familiarizing students with current research and theory as well as with practices in document design. Students design, produce, and evaluate documents for a variety of applications, such as instructional materials, brochures, newsletters, graphics, and tables.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 529
Technical Editing
Principles and practical applications of editing at all levels, working with both hard and soft copy and including copymarking, copyediting, proofreading, grammar and style, and comprehensive editing. Attention primarily to documents from science, technology, and business.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 530
Standards-Based Web Design
Theory and practice of structuring and designing information for web-enabled devices. This course emphasizes web standards, accessibility, and agile design methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 531
Web Application Development
A production-intensive course in applied theory and practice of developing web-based applications emphasizing interface and experience design using emerging Web standards and backend development using Ruby-based web application frameworks.
Prerequisite(s): [(COM 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 532
Rhetoric of Technology
A course that explores the theoretical and applied intersections of the rhetorical tradition and digital communication technologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 533
Application Programming Interfaces
A production-intensive course in the theory and applied practice of working with application programming interfaces (APIs), especially Web-available APIs for exchanging and mashing up content and data.
Prerequisite(s): [(COM 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 535
Instructional Design
Teaches the essentials for the development of instructional materials, including analysis of human performance problems, strategic interventions, specified learning tasks, and validation instruments.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 536
Proposal and Grant Writing
Course covers all aspects of federal and foundation proposal cycle, from proposal development through review and decision-making process. Emphasis on research proposals incorporating quantitative and qualitative methods, but activity-based proposals addressed as well.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 538
Entrepreneurship in Technical Communication
Corporate and independent roles of technical communicators. Concepts and techniques needed to market services or to address the marketing needs of clients. Modes, goals, and strategies for verbal and written interaction with clients, corporate decision-makers, and communications staff, with attention to presentation technologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 541
Information Structure and Retrieval
An examination of conceptual foundations and applied uses of structured languages and databases for structuring information with an emphasis on approaches to single-sourcing materials for presentation in digital and print formats.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 542
Knowledge Management
Analysis of the nature and uses of knowledge in organizations and groups with attention to technical communicators' roles and tasks in collecting, codifying, storing, retrieving, and transferring information within organizations. Emphasis on web-based strategies, techniques, and tools.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 543
Publication Management
Intensive work developing and using systems to create and deliver content digitally and in print. Special emphasis on project management and large-team collaboration. Formerly known as COM 537.
Prerequisite(s): [(COM 530*) OR (COM 541*) OR (COM 542*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 545
Writing for Academic Publication
Practice in developing written and spoken academic genres (e.g., reviews, articles, conference papers, CVs, job talks). Special attention to analyzing and evaluating academic journals; submitting items to journals and conferences; managing time during the research, writing, and publication process; revising work and providing feedback to others; and mastering the conventions of academic writing.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 552
Gender and Technological Change
Have you ever wondered why more men choose to portray themselves as women online than the reverse? Or why there are more boys than girls in China? Or why vibrator technology was seen as a medical necessity in the 19th century? Have you ever thought about how the interplay between technology and gender constructs everything from our modern military to how we choose to spend our free time? To where we work? This course explores the history of technology by using gender as a category of analysis. It also looks at how technological objects and tools participate in molding elements of our culture that we may take for granted as logical or timeless. By looking at change over time, we will analyze the different ways technology affects how we live and see ourselves and how gender defines technological priorities.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 553
Globalization and Localization
The examination and application of research on cultural dimensions in communication such as individualist versus collectivist. Also, an examination of topics from a theoretical linguistic perspective such as contrastive rhetoric. These topics are then related to best practices in web and document design.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 554
Science and Technology Studies
This course focuses on the latest work in science and technology studies and the history of technology from ethics in genetic engineering to the social dimensions of computing. Other topics include the intersection of gender and sexuality with new technologies, the role of communications media in "rewiring" our brains and our social connections, and the role of the world wide web in constructing national and global technocracy. In the course, students will read and discuss works by academics as well as journalists in order to offer grounding in the historical, social, and economic background of key technical topics and the presentation of technical topics for wider audiences. The course will also focus on the ways in which authors leverage different information technologies to communicate to wider audiences and how those methods are evolving.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 561
Teaching Technical Communication
Principles, strategies, and resources for teaching technical communication and for developing and assessing technical communication curricula, especially at the postsecondary level.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 571
Persuasion
The study of covert and overt persuasion and their influences on society and individuals.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 574
Communications in Politics
This course introduces students to the general theories and practices of political campaign communication today. It investigates how those rules and types apply in the current presidential campaign. More generally, the course teaches students to produce written and oral discourse appropriate to the humanities.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 577
Communication Law and Ethics
This course explores ethical and legal issues concerning communication in diverse contexts, such as: the mass media - e.g. print, broadcast, and electronic; government and politics; organizational hierarchies - e.g. public and private sector workplaces; academic life - e.g. the classroom, student, and faculty affairs; and interpersonal relations - e.g. love, friendship, marriage. Students will research and write an article length paper, and may also do additional research and/or classroom work.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 580
Topics in Communication
An investigation into a topic of current interest in communication, which will be announced by the instructor when the course is scheduled.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 583
Social Networks
This course will discuss a variety of measures and properties of networks, identify various types of social networkds, describe how position within and the structure of networks matter, use software tools to analyze social network data, and apply social network analysis to areas such as information retrieval, social media, and organizational behavior.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 584
Humanizing Technology
This course will investigate and experiment with both conceptual and applied efforts to humanize technology, especially computer technology. We will question the goals of humanization and its relationships to concepts such as design ethics and user-centered and emotional desigh. While the ficus of the class will be on computer technology and programming languages, we will also look at humanization with regard to industrial design, enginereing, architecture, and nanotechnologies.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 585
Internship
The internship is a cooperative arrangement between IIT and industry. It provides students with hands-on experience in the field of technical communication and information design.
Credit: Variable

COM 591
Research and Thesis for Master's Degree
Permission of instructor required.
Credit: Variable

COM 594
Project
Projects will require students to complete a theoretically based analysis of a practical communication situation, create a document appropriate to the situation, and write and analysis of or commentary on the choices made in the production of the document. (Credit: Variable. Most M.S. students take 6 credits of project studies)
Credit: Variable

COM 597
Special Problems
Permission of instructor required.
Credit: Variable

COM 601
Research Methods and Resources
This course addresses the logic of research design. The first part of the course focuses on formulating clear research questions and hypotheses. The second part addresses various designs (surveys, correlations, experiments, mixed designs, etc.) and their potential to test hypotheses.
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 602
Qualitative Research Methods
This course is intended for graduate students in technical communication and related fields who are planning to conduct qualitative research in a variety of settings.
Prerequisite(s): [(COM 601)]
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 603
Quantitative Research Methods
This course is for doctoral students of technical communication who have a command of general research methods but who require a deeper understanding of methods for the collection and analysis of quantitative data.
Prerequisite(s): [(COM 601)]
Lecture: 3 **Lab:** 0 **Credits:** 3

COM 691
Research & Thesis Ph.D.
This is a variable credit course which Ph. D. candidates sign up for as they work on their dissertations. Permission of instructor required.
Credit: Variable

HIST 580
Topics in History
A course for graduate students on a topic in history.
Lecture: 3 **Lab:** 0 **Credits:** 3

HIST 597
Special Problems: History
Advanced topics in the study of history , in which there is special student and faculty interest. Variable Credit: 1-6.
Credit: Variable

HIST 691
Research and Thesis PhD
This course is for PhD students whose dissertation requires working with a historian.
Lecture: 0 **Lab:** 0 **Credits:** 20

HUM 601
Teaching Assistant Seminar
Required of all teaching assistants at IIT, this course introduces students to classroom and course management issues, strategies, and ethics. In addition, students give classroom-lecture style presentations using basic instructional visual aids.
Lecture: 0 **Lab:** 0 **Credits:** 0

HUM 610
Technology and Humanities Seminar
This seminar emphasizes professional skills and practices to aid students in completing their degrees and transitioning into professional careers, whether those are inside or outside the academy.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 551
Science and Values
This course will consider questions such as: What role should values play in scientific inquiry? Should scientists consider only epistemic or cognitive values, or should they take into account social and cultural values? Could science be objective and make progress if it is shaped by social and cultural values?.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 560
Ethics
A study of the fundamental issues of moral philosophy.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 570
Engineering Ethics
A study of moral and social responsibility for the engineering profession including such topics as safety, confidentiality, and government regulation.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 571
Ethics in Architecture
A study of the moral problems architects must resolve in the practice of their profession, including problems of confidentiality, candor, esthetics, and economy, arising from the special responsibilities of architects to the public, client, employer, and colleagues.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 573
Business Ethics
Ethical issues relating to individual and corporate responsibility, self and governmental regulation, investment, advertising, urban problems, the environment, and preferential hiring.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 574
Ethics in Computer Science
Moral problems that confront professionals in computer-related fields, including questions raised by the concept of intellectual property and its relationship to computer software, professional codes of ethics for computer use, and responsibility for harm resulting from the misuse of computers.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 580
Topics in Philosophy
An investigation into a topic of current or enduring interest in philosophy, which will be announced by the instructor when the course is scheduled. Graduate standing required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHIL 597
Special Problems in Philosophy
Advanced topics in the study of philosophy, in which there is special student and faculty interest. Variable Credit: 1-6 Prerequisite: Instructor permission required.
Credit: Variable

PHIL 691
Research and Dissertation
This a research hours course for PhD candidates who need to consult with a philosopher on their dissertation.
Credit: Variable

Master of Science in Technical Communication and Information Architecture

33 credit hours
TCIA core (18 credit hours)
Electives (minimum of 9 credit hours)
Project or thesis (minimum of 3 credit hours)
Project review or thesis exam

The M.S. in Technical Communication and Information Architecture enhances a technical communication core with specialized concepts, skills, and tools for designing, implementing, and managing websites and related digital media. This degree provides students with expertise for a number of tasks relevant to mid-level and advanced positions in the workplace: website design, website project management, information structure and retrieval, knowledge management, and usability testing and evaluation.

Curriculum

Students preparing for careers in industry are advised to take the project option, while students preparing for a Ph.D. may wish to take the thesis option. The exam committee for each option requires two Category 1 faculty members from the Department of Humanities, at least one of them from the graduate program in technology and humanities. Students may apply up to 6 credit hours in one of the following courses: COM 594 or COM 591.

Required Courses		(18)
COM 525	User Experience Research and Evaluation	3
COM 528	Document Design	3
COM 529	Technical Editing	3
COM 530	Standards-Based Web Design	3
COM 531	Web Application Development	3
COM 541	Information Structure and Retrieval	3
or COM 542	Knowledge Management	
or COM 543	Publication Management	
Electives		(9-12)
Select 9-12 credit hours [1]		9-12
Master's Research		(3-6)
COM 594	Project [2]	3-6
or COM 591	Research and Thesis for Master's Degree	

Minimum degree credits required: 33

1 9-12 credit hours of any 500-level COM course, or other relevant 500-level course within the Department of Humanities; or, with adviser and director approval, any 500-level course elsewhere in the university where a student meets the prerequisites.

2 Students pursuing the project option are required to take between 3-6 credit hours of COM 594; students pursuing the thesis option require between 3-6 credit hours of COM 591.

Master of Science in Technology and Humanities

33 credit hours
TH core (18 credit hours)
Electives (minimum of 12 credit hours)
Project or thesis (minimum of 3 credit hours)
Project review or thesis exam

Curriculum

Students preparing for careers in industry are advised to take the project option, while students preparing for a Ph.D. may wish to take the thesis option. The exam committee for each option requires two Category 1 faculty members from the Department of Humanities, at least one of them from the graduate program in technology and humanities. Students may apply up to 6 credit hours in one of the following courses: COM 594 or COM 591

Required Courses		(18)
COM 521	Theory in Technology and Humanities	3
COM 538	Entrepreneurship in Technical Communication	3
COM 545	Writing for Academic Publication	3
COM 601	Research Methods and Resources	3
HUM 610	Technology and Humanities Seminar	3
COM 602	Qualitative Research Methods	3
or COM 603	Quantitative Research Methods	
Additional Required Courses		(12)
Select a minimum of one course from each of the categories below:		12
Communication and Media Studies group (see options below)		
Linguistics group (see options below)		
Any 400- or 500-level course in history		
Any 400- or 500-level course in philosophy		
Master's Research		(3-6)
COM 594	Project [1]	3-6
or COM 591	Research and Thesis for Master's Degree	

Minimum degree credits required: 33

1 Students pursuing the project option are required to take between 3-6 credit hours of COM 594; students pursuing the thesis option require between 3-6 credit hours of COM 591.

Communication and Media Studies

COM 528	Document Design	3
COM 530	Standards-Based Web Design	3
COM 531	Web Application Development	3
COM 532	Rhetoric of Technology	3
COM 541	Information Structure and Retrieval	3
COM 552	Gender and Technological Change	3
COM 553	Globalization and Localization	3
COM 554	Science and Technology Studies	3
COM 571	Persuasion	3
COM 574	Communications in Politics	3
COM 577	Communication Law and Ethics	3
COM 584	Humanizing Technology	3

Linguistics

COM 501	Introduction to Linguistics	3
COM 506	World Englishes	3
COM 508	Structure of Modern English	3

COM 509	History of the English Language	3
COM 510	The Human Voice: Description, Analysis, and Application	3
COM 515	Discourse Analysis	3

Doctor of Philosophy in Technology and Humanities

72 credit hours beyond the bachelor's degree, including:

- Core curriculum (30 credit hours)
- Electives (minimum of 15 credit hours)
- Dissertation research (minimum of 24 credit hours)
- Additional electives or dissertation research (as needed to achieve total of 72 credit hours)

Qualifying examination
Comprehensive examination
Dissertation proposal
Dissertation
Dissertation (final thesis) examination

Transfer Units

Students who have already earned master's degrees or undertaken graduate work in relevant fields may transfer credit hours toward the doctoral degree (up to 36 credit hours for graduate coursework in relevant fields at Illinois Institute of Technology, up to 30 credit hours for graduate coursework in relevant fields at other institutions).

Curriculum

Core Courses		(18)
COM 521	Theory in Technology and Humanities	3
COM 538	Entrepreneurship in Technical Communication	3
COM 545	Writing for Academic Publication	3
COM 601	Research Methods and Resources	3
COM 602	Qualitative Research Methods	3
or COM 603	Quantitative Research Methods	
HUM 610	Technology and Humanities Seminar	3
Additional Required Courses		(12)
Select a minimum of one course from each of the categories below:		12
Communication and Media Studies group		
Linguistics group		
Any 400- or 500-level course in history		
Any 400- or 500-level course in philosophy		
Specialization Courses		(15)
Select 15 credit hours from the Communication and Media Studies, Linguistics, or Technical Communications groups, or a student-proposed, adviser-approved specialization of 15 credit hours.		15
Ph.D. Research		(24-36)
COM 691	Research & Thesis Ph.D. [1]	24-36

Minimum degree credits required: 72

1 Students exceeding the allowed 36 credit hours of research will be denied further study and will be removed from the program.

Technology and Humanities Areas of Concentration

Communication and Media Studies

COM 528	Document Design	3
COM 530	Standards-Based Web Design	3
COM 531	Web Application Development	3
COM 532	Rhetoric of Technology	3
COM 541	Information Structure and Retrieval	3
COM 552	Gender and Technological Change	3
COM 553	Globalization and Localization	3
COM 554	Science and Technology Studies	3
COM 571	Persuasion	3
COM 574	Communications in Politics	3
COM 577	Communication Law and Ethics	3
COM 584	Humanizing Technology	3

Linguistics

COM 501	Introduction to Linguistics	3
COM 506	World Englishes	3
COM 508	Structure of Modern English	3
COM 509	History of the English Language	3
COM 510	The Human Voice: Description, Analysis, and Application	3
COM 515	Discourse Analysis	3

Technical Communication

COM 503	Analyzing and Communicating Quantitative Data	3
COM 511	Linguistics for Technical Communication	3
COM 523	Communicating Science	3
COM 525	User Experience Research and Evaluation	3
COM 528	Document Design	3
COM 529	Technical Editing	3
COM 530	Standards-Based Web Design	3
COM 531	Web Application Development	3
COM 535	Instructional Design	3
COM 541	Information Structure and Retrieval	3
COM 542	Knowledge Management	3
COM 543	Publication Management	3
COM 561	Teaching Technical Communication	3
COM 571	Persuasion	3
COM 574	Communications in Politics	3
COM 577	Communication Law and Ethics	3
COM 585	Internship	1-20

Elective Courses

Up to 15 credit hours of any 400- or 500-level coursework with adviser approval. A maximum of 9 credit hours of 400-level courses may be used.

Additional Courses

Additional coursework or dissertation research sufficient to meet the requirement of 72 credit hours beyond the bachelor's degree. All work for a doctoral degree should be completed within six calendar years after the approval of the plan of study; if it is not, then the student must re-pass the qualifying examination.

Examinations

The **Qualifying Examination** assesses a student's analytical ability, writing skills, and research potential. The exam must be taken by the end of the student's third semester in the Ph.D. program. Each student prepares a brief statement of research interests and a qualifying paper—a sole-authored research paper of at least 5,000 words, demonstrating original analysis and familiarity with existing research. The examining committee consists of three Category I faculty, at least two from the technology and humanities program. Based on exam results, the committee may recommend changes to the student's Plan of Study. If the student fails the qualifying examination, the committee may recommend a re-examination. The second attempt at the exam is regarded as final.

The **Comprehensive Examination** assesses a student's expertise and ability to apply the literature in three research areas. The exam should be taken by the end of the student's third year in the Ph.D. program. The examining committee consists of three Category I faculty from the technology and humanities program and one from a Ph.D.-granting academic unit at the university other than the Department of Humanities. The student works with the committee to select research areas and develop a reading list for each one. Areas and reading lists must be approved by all committee members prior to the exam. A timed, written exam requires the student to respond to one or more questions in each area. The committee may recommend a re-examination over any area(s) that the student fails. The second attempt at the exam is regarded as final.

The **Dissertation Proposal** is a detailed written plan for original research that will culminate in the dissertation. The proposal is typically presented within one semester after the student has passed the comprehensive examination. The proposal is developed under the guidance of the student's major adviser and typically addresses:

1. the research problem or issue to be investigated
2. its significance to the field
3. a thorough review of relevant research
4. a detailed description of and rationale for the research method(s) to be used
5. a plan of work
6. a statement of anticipated results or outcomes

The proposal review committee consists of four Category I faculty: three from technology and humanities and one from a Ph.D.-granting academic unit at the university other than the Department of Humanities. The committee must formally approve the proposal before the student begins further work on the dissertation. As part of the review process, the committee may request one or more meetings with, or presentations by, the student.

The **Final Thesis Examination** is an oral defense of the dissertation. The dissertation committee consists of four Category I faculty: three from technology and humanities and one from a Ph.D.-granting academic unit at the university other than the Department of Humanities. A student who fails the exam may be re-examined after 30 days. The second attempt at the exam is regarded as final.

The **Dissertation** should constitute an original contribution to scholarship in technology and humanities and may address areas of interaction between technology and humanities and other disciplines (e.g., history, linguistics, literature, philosophy, and rhetoric/composition). The research topic and method may be empirical (perhaps employing the facilities of the Humanities and Technology Lab or Speech Analysis Lab), pedagogical, historical, or theoretical.

Certificate in Instructional Design

This certificate is primarily for experienced technical communicators who wish to acquire focused competency in instructional design. Graduates of this certificate program can serve as information specialists to systematically design and develop instructional materials and training programs for businesses, individuals, health and education institutions, and government. This certificate teaches the core concepts, instructional methods, and assessment instruments for designing materials using various forms of text, visual media, technology, and instructional techniques.

Curriculum

Required Courses		(15)
COM 424	Document Design	3
or COM 528	Document Design	
COM 525	User Experience Research and Evaluation	3
COM 530	Standards-Based Web Design	3
COM 535	Instructional Design	3
COM 542	Knowledge Management	3
Total Credit Hours		15

Certificate in Technical Communication

This certificate is designed for students seeking an entry-level position as a technical communicator in a broad range of fields (e.g., industry, manufacturing, health care, publishing and advertising, and government agencies).

Curriculum

Required Courses			(12)
COM 424	Document Design		3
or COM 528	Document Design		
COM 525	User Experience Research and Evaluation		3
COM 425	Editing		3
or COM 529	Technical Editing		
Select a minimum of one course from the following:			3
COM 428	Verbal and Visual Communication	3	
COM 435	Intercultural Communication	3	
COM 523	Communicating Science	3	
COM 530	Standards-Based Web Design	3	
Total Credit Hours			12

Psychology

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Chair
Michael Young

Associate Chair
Frank Lane

Director, Clinical Psychology
Joyce Hopkins

Director, Industrial and Organizational Psychology
Roya Ayman

Director, Counseling and Rehabilitation Science
Eun-Jeong Lee

Faculty with Research Interests
For more information regarding faculty visit the Department of Psychology website.

The Department of Psychology offers graduate programs in clinical psychology, industrial/organizational (I/O) psychology, rehabilitation counseling education, and rehabilitation and mental health counseling. The department's goal is to provide students with a scientist-practitioner model of training that integrates theory, research, and practice. Each program requires specific research, practicum, internship, and curricular activities, which are linked to the specific goals of the individual training program.

Research Centers

Psychology faculty and students collaborate on applied research projects through the Center for Research and Service (CRS). Founded as the IIT Institute for Psychological Services in 1943, the CRS has an exceptional track record of providing organizations with meaningful metrics for managing human resources and has existed as a consulting unit since 1998. Leveraging the skills of faculty, students, and staff, the CRS evolved into one of the country's premier university-based research and services firm. Today, the CRS employs a staff of four full-time consulting professionals, approximately 30 Ph.D. students, and 12 faculty from our industrial/organizational, clinical, and rehabilitation psychology programs.

The National Consortium on Stigma and Empowerment (NCSE) is a research group meant to promote recovery from mental illness by understanding the stigma associated with mental illness and promoting personal empowerment. The consortium (ncse1.org), largely funded by NIMH, is located at Illinois Institute of Technology, directed by Patrick Corrigan, and includes a collection of researchers at Yale University, the University of Pennsylvania, Rutgers University, Temple University, Dartmouth University, the University of Illinois-Chicago, and New York University.

Research Facilities

Facilities include laboratories for human behavioral assessment studies, psychophysiological research, infant and maternal attachment research, and testing and interviewing laboratories with one-way mirror viewing. Special computer and video equipment are part of the research facilities. There are graduate student offices, a testing library, and a student lounge. Many journals and databases are available through the university's libraries.

Research Areas

Clinical psychology faculty interests include: health psychology, attachment, child social and emotional development, educational assessment, eating disorders, and mood disorders. Some clinical students work with rehabilitation faculty in areas such as: adjustment to disability, stages of change, stigma and prevention, psychiatric rehabilitation, and cross-cultural issues.

Industrial/organizational faculty interests include: leadership, diversity, organizational climate, work-family interface, training design and evaluation, performance appraisal, test development, selection bias, occupational health psychology, and item response theory. Counseling and rehabilitation science faculty pursue research in the areas of: mental health counseling, adjustment to disability, vocational rehabilitation, factors affecting job placement, rehabilitation engineering technology, psychiatric rehabilitation, ethics and ethical issues in counseling, and clinical supervision.

Program Descriptions

The Clinical Psychology Program offers a Ph.D. in Psychology with a specialization in Clinical Psychology. The clinical psychology Ph.D. program has been fully accredited for over 25 years by the American Psychological Association, and offers training from the cognitive-behavioral framework. Based on the Boulder scientist-practitioner model, the program emphasizes an integration of clinical practice and applied clinical research. Working with a faculty mentor, students begin research work their first year. Students in the rehabilitation specialization track take rehabilitation courses as electives and do research with rehabilitation faculty. Clinical practicum experiences take place at general and specialized clinical sites throughout the Chicago area. All students complete an APA-accredited internship. The program prepares students to be license-eligible in the state of Illinois and most other states. Graduates typically function as practitioners and researchers in medical centers and multi-disciplinary clinical settings.

The Industrial/Organizational Psychology Program offers an M.S. in Personnel and Human Resources Development and a Ph.D. in Psychology with a specialization in Industrial/Organizational Psychology. The program emphasizes a science-practice model of training. Students undertake a balanced education in personnel and organizational topics, disciplines and research. The program strengthens students' quantitative skills for research and consulting. All students are expected to complete two internships. These positions are within various organizations where students are responsible for human resource management and development functions. Students in the personnel and human resource development master's degree program receive the knowledge and skills necessary for professions in human resources, as well as management consulting positions. Ph.D. students will acquire a strong theoretical and methodological background in various areas of I/O psychology and are required to complete a minimum of two research projects. Many students in the past have presented and published their work. The Ph.D. curriculum prepares students to choose from several career paths in consulting, corporate human resources, or research and teaching.

The Counseling and Rehabilitation Science Program offers an M.S. in Rehabilitation and Mental Health Counseling, a Ph.D. in Psychology with a specialization in Rehabilitation Counseling Education, and a Ph.D. in combined clinical/rehabilitation psychology. The mission of the Rehabilitation and Mental Health Counseling Program is to prepare master's degree students to perform a vital role as counselors who have specialized knowledge and skills for both rehabilitation and clinical mental health counseling service delivery. This includes the ability to serve persons with a diverse array of problems impacting the individual, and/or the family, in a variety of clinical settings and with respect for the influences of multicultural factors such as culture, ethnicity, race, religion, gender, and sexual orientation. Students also receive specialized training in the vocational, educational, and personal adjustment of persons with physical, mental, and emotional disabilities. The objectives of the program are to:

1. Train individuals in the practice of rehabilitation and clinical mental health counseling, which includes specialized knowledge in and experience related to counseling and treatment modalities appropriate for the service of a variety of clients in diverse rehabilitation and mental health counseling settings;
2. Develop mature, capable professionals who are able to relate constructively to clients, to work with clients to facilitate behavior change, demonstrate therapeutic interaction skills, and to facilitate the client's development of problem-solving skills; and
3. Prepare students for professional service and leadership within the fields of rehabilitation and mental health counseling.

The program also provides advanced training for persons presently employed in agencies and facilities offering services to persons with disabilities. This program prepares counselors for employment in community mental health facilities; state, federal, and private rehabilitation agencies; hospitals; correctional institutions; public schools; rehabilitation centers; and other organizations serving persons with physical, psychiatric, mental, social or emotional disabilities. The Ph.D. program prepares individuals for careers in university teaching, research, and clinical practice in rehabilitation psychology. A minor is required for the rehabilitation counseling education track.

Special Fellowships

Since its inception, the Rehabilitation Services Administration (RSA) of the U.S. Department of Education has continuously funded the university's rehabilitation counselor education programs. The RSA traineeships are designed to increase the number of practicing rehabilitation counselors for the state/federal vocational rehabilitation program by covering the cost of tuition and books. Traineeship grants, when available, may cover up to full tuition plus a monthly stipend. To a limited number of students, the department also awards teaching and research assistantships, which cover partial tuition as well as provide a stipend. The amount of the stipend and tuition scholarships depends upon the terms of the appointment.

Admission Requirements

Cumulative undergraduate GPA minimum

3.0/4.0

GRE score minimum for M.S./Ph.D.

298 (quantitative + verbal); 3.0 (analytical writing)

Minimum TOEFL score

550/213/80[1]
Three letters of recommendation

The master's program in rehabilitation and mental health counseling does not require the GRE. Each degree program is unique, but the stated minimum requirements are typical values and meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. At least 18 credit hours of undergraduate study in psychology are required.

Applicants for master's degree programs should have a bachelor's degree from an accredited institution and meet the minimum standards listed above. The exception is the master's in rehabilitation and mental health counseling; undergraduate general psychology courses are the only required prerequisites for that program. Prerequisite to admission to doctoral programs are a bachelor's or master's degree from an accredited institution, superior academic records in both undergraduate and graduate programs, and favorable academic recommendations. GRE results are required for all psychology doctoral programs. Applications for admission are evaluated by separate committees for each program (clinical, industrial/organizational, rehabilitation, rehabilitation counseling education, and rehabilitation and mental health counseling). Therefore, a prospective student must designate a specialty area on the appropriate form.

1 Paper-based/computer-based/internet-based test score.

Degrees Offered

- Master of Science in Personnel and Human Resources Development (p. 352)
- Master of Science in Psychology (p. 353)
- Master of Science in Rehabilitation and Mental Health Counseling (p. 354)
- Master of Science in Rehabilitation and Mental Health Counseling with Advanced Standing (p. 355)
- Doctor of Philosophy in Psychology with Specialization in Clinical Psychology (p. 356)
- Doctor of Philosophy in Psychology with Specialization in Industrial/Organizational Psychology (p. 357)
- Doctor of Philosophy in Psychology with Specialization in Rehabilitation Counseling Education (p. 358)

Combined Degree Programs

- Bachelor of Science in Psychology/Master of Science in Personnel and Human Resources Development (p. 352)

Certificate Programs

- Psychiatric Rehabilitation (p. 360)
- Rehabilitation Counseling (p. 360)
- Rehabilitation Engineering Technology (p. 360)

Course Descriptions

PSYC 501
Biological Bases of Behavior
A critical review of the anatomical and neurophysiological bases of behavior as related to theory and practice in psychology.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 502
Social Bases of Behavior
Critical overview of theory and research in social cognition, interpersonal relations, group dynamics and organizational psychology. Implications of principles for issues and problems in real-world social systems are developed.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 503
Learning and Cognition
Overview of theory and research in topics related to learning, communication, attention, perception, memory, reasoning, and decision making. Emphasis will be placed on connecting theoretical perspectives to real-world applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 504
Individual and Cultural Differences
Review of the basic models used to explore and explain how and why people differ from each other. The course will explore the influence of culture and individual characteristics such as gender, ability and personality, as well as how these influences change over a person's lifetime.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 505
History and Systems of Psychology
Critical and conceptual evaluation of influential philosophical and psychological theories of human behavior: From the Greek bronze age to the modern era.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 506
Therapy I
Basic clinical skills including intake, suicide assessment, case formulation, differential diagnosis, and basics of conducting cognitive behavioral therapy. Taken when not preceded by PSYC 518 (Basic Clinical Skills).
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 507
Therapy II
Second semester seminar and supervised training in basic clinical skills, including interviewing, development of a therapeutic relationship, managing the process of therapy and assessing therapy progress. Requires active standing in the clinical program and approved clinical placement.
Prerequisite(s): [(PSYC 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 508
Ethics and Professional Issues I
This is an introductory course designed around ethical issues confronting clinical psychologists. It is offered to incoming first year clinical students to allow them to think about ethical issues in treatment, assessment, and professional behavior. Using the APA ethics code as a guide, students present and respond to ethical dilemmas that they may face as they embark upon their career as clinical psychologists. Other professional issues are also discussed including the transition to graduate school, course selection decisions, and any other general graduate school questions that may arise.
Lecture: 2 **Lab:** 0 **Credits:** 2

PSYC 509
Ethics and Professional Issues II
This is a continuation of PSYC 508 but offered to second semester, third year students. It is designed to prepare students for the later parts of the graduate student experience. Topics include dissertation research, the internship experience, early job and career decisions, supervision, and consultation. Barriers to successful completion of the program are discussed and problem solved. Ethical issues such as those confronting new Ph.D.'s are also introduced.
Lecture: 1 **Lab:** 0 **Credits:** 1

PSYC 510
Clinical Assessment I
Seminar and supervised training in intellectual and cognitive assessment for adults and children. Research, psychometric characteristics, conceptual foundations, clinical applicability, administration, scoring and interpretation of major assessment instruments, and writing reports. Requires active standing in the clinical program. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 511
Psychometric Theory
Basic understanding of principles and theories of psychological measurement emphasizing (1) theories and methods for estimation of reliability and validity, (2) techniques for the measurement of psychological variables and (3), methods for construction of psychological and educational measuring instruments.
Prerequisite(s): [(PSYC 545 and PSYC 546)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 512
Clinical Assessment II
Seminar and supervised training in personality assessment of adults and children. Research, psychometric characteristics, conceptual foundations, clinical applicability, administration, scoring and interpretation of major assessment instruments, and writing reports.
Prerequisite(s): [(PSYC 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 513
Assessment in Rehabilitation and Mental Health Counseling
An overview of test selection, administration, and interpretation through synthesis, integration, and evaluation of assessment data used in rehabilitation and mental health counseling. Includes historical perspectives in assessment, statistical concepts, an orientation to standardized and non-standardized tests, and the process and practice of assessing adults with disabling conditions for rehabilitation plan development and vocational decision-making.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 514
Vocational Evaluation II: Report Development and Communication
The process of developing vocational evaluation and staffing reports. Gathering, analyzing, integrating, synthesizing, and interpreting evaluation information. Development of feasible recommendations utilizing related sources of labor market/ occupational information.
Prerequisite(s): [(PSYC 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 515
Vocational Evaluation Laboratory
Practical skills in vocational evaluations including application of work samples and situational assessment at a vocational evaluation site in the community.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 517
Performance Appraisal Seminar
The objectives of the seminar are to 1) provide a broad understanding of the multiple facets of performance appraisal, 2) understand research and advances in the field, and 3) understand the challenges and pitfalls of successfully implementing a PA system in an organization.
Prerequisite(s): [(PSYC 529 and PSYC 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 518
Basic Clinical Skills
This course covers introductory therapy skills including intake, suicide assessment, case formulation, and differential diagnosis.
Prerequisite(s): [(PSYC 526)]
Lecture: 1 **Lab:** 0 **Credits:** 1

PSYC 519
Therapy I-A
Basics of conducting cognitive behavioral therapy following PSYC 518 (Basic Clinical Skills).
Prerequisite(s): [(PSYC 518)]
Lecture: 2 **Lab:** 0 **Credits:** 2

PSYC 520
Health Psychology
Introduction to theoretical, clinical and research issues in adult behavioral medicine. Covers general perspectives of a biobehavioral approach, factors affecting adult health and illness, diagnostic and treatment approaches, and issues in research and application.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 523
Introduction to Theories of Psychotherapy
Introduction to various approaches to therapeutic intervention. The conceptual bases, history, methods, empirical foundations and applicability of important schools of therapeutic intervention will be considered.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 524
Assessment and Treatment of Infants and Young Children
Reviews current conceptualizations, assessment and treatment of childhood disorders from a behavioral-system perspective. Examines the impact of the family, school and other relevant systems on the development and treatment of child behavior problems.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 525
Developmental Psychopathology
This course covers theory and research on developmental processes and their functions to promote health and as risk factors for psychopathology.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 526
Psychopathology
Critical examination of clinical and experimental research in psychopathology and diagnostic classification systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 529
Personnel Selection and Evaluation
Principles and techniques of employee selection and placement. Analysis of test data which will maximize the effectiveness of such techniques.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 530
Contemporary Issues in Industrial Organizational Psychology
The overall objectives of this seminar are to (a) provide exposure to the theoretical and applied literatures on meta-analysis, and (b) develop skills in critiquing and conducting meta-analyses. The major areas of theory and research that will be examined in this course include (a) the conceptual and measurement literatures focusing on individual difference constructs, (b) an introduction to classical reliability theory and statistical theory underlying meta-analysis procedures, and (c) studies evaluating the generalizability of relationships involving individual differences and situational variables. Additionally, the course also discusses concepts related to utility analysis (with particular attention paid to intersections with meta-analytic work).
Prerequisite(s): [(PSYC 529, PSYC 546, and PSYC 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 531
Organizational Attitudes and Behavioral Seminar
The course is an in-depth study of factors that affect Organizational behavior and attitude (motivational theories). The various key attitudes and behaviors that organizations are defined and research relating to them is discussed (e.g. job satisfaction, organizational commitment, job involvement, turnover, absenteeism, and organizational citizenship). We also identify the stresses on today's employees' life and discuss some ways to manage them (e.g. job stress, work-family conflict, minority and immigrant worker.
Prerequisite(s): [(PSYC 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 532
Occupational Health Psychology
This survey course is designed to provide a broad overview of the field of occupational health psychology (OHP). OHP is an exciting field that examines the bidirectional relationship between work psychology on the one hand and individual and organizational health on the other. We will review major theories and empirical research linking work and organizational factors (organizational justice, dark workplace behaviors such as incivility, shift-work, work-family interface) with employee health and well-being (stress, affect, job-burnout, recovery experiences) along with interventions and experiences designed to promote occupational health.
Prerequisite(s): [(PSYC 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 533
Clinical Practicum
Clinical assessment, therapy and/or consultation in a community-based mental health setting or medical facility for an average of 15 to 20 hours per week, per semester. Students obtain supervised experience in the provision of psychological services and related professional activities. Must be in an approved clinical placement site.
Credit: Variable

PSYC 534
Attachment Theory Throughout the Lifespan
Provides an in depth understanding of attachment theory and research, as well as clinical applications throughout the life span. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 535
Seminar in Personnel Selection
A critical review of advanced techniques in personnel selection. Includes such topics such as validity generalization, utility analysis, and applications of latent trait theory.
Prerequisite(s): [(PSYC 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 536
Affective Disorders
Examination of current theory and research regarding affective disorders. Covers cognitive, behavioral, biological, and cultural perspectives. The relationship of affective symptomatology and diagnosis to other types of psychopathology are considered.
Prerequisite(s): [(PSYC 526)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 537
Child Cognitive Development
The course is designed to be a practical primer on the changes in cognition that occur from ages five to seven when there is a major change in how children perceive their world and how the world perceives them.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 538
Psychology of Sport, Performance, and Health
The course examines the clinical and research literature on the physical and psychological benefits of the following: regular physical activity; psychological, social, and environmental aspects of exercise non-adherence; and mental and behavioral strategies for promoting motivation, confidence, concentration, and enhanced sport performance.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 540
Research Methods
This course prepares students for designing and interpreting empirical research. The collection of meaningful data, appropriate use of data analytic techniques, and the interpretation of data results are presented.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 545
Graduate Statistics I
Basic course in elementary statistics Introduction to inferential statistics and statistical analysis of psychological data. Emphasis on hypothesis testing procedures and computer applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 546
Graduate Statistics II
Statistical procedures used in the prediction and explanation of psychological data, including multiple regression. Emphasis on computer applications.
Prerequisite(s): [(PSYC 545)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 547
Evidence-Based Practice in Rehabilitation and Mental Health Counseling
The objective of this course is to familiarize students with evidence-based practice (EBP) in the field of rehabilitation and mental health counseling. Students will be introduced to a variety of evidence-based models in rehabilitation and mental health counseling as well as current issues in EBP. The historical development of EBP will be explored, and current empirical research will be examined.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 548
Vocational Psychiatric Rehabilitation
An in depth review of models available to help people with severe mental illness obtain and maintain employment. Topics relating to vocational evaluation, work adjustment, placement, supported work models, and follow-up will be covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 549
Practicum in Rehabilitation and Mental Health Counseling
Seminar and supervised experience in rehabilitation and mental health counseling with an emphasis on development of individual counseling skills. Students work in a field-based rehabilitation and mental health counseling capacity carrying a small client caseload while participating in weekly individual and group supervision. Includes topics related to counseling processes, procedures, and theories; ethics; and crisis prevention, assessment, and intervention.
Prerequisite(s): [(PSYC 410, PSYC 523, and PSYC 557)]
Credit: Variable

PSYC 550
Couples Research and Therapy
Advanced seminar introduces students to empirically based interventions for couples. Presents clinically relevant and empirically derived material to better understand the importance of both technique and theory when intervening at a couples level.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 552
Legal Issues in Human Resource Management
Seminar on the legal context of human resource management, focusing on equal employment opportunity laws. Will discuss how to design employee selection, evaluation and compensation systems that comply with U.S. federal laws and regulations.
Prerequisite(s): [(PSYC 529)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 553
Family and Couples Therapy
Surveys the major theoretical perspectives for understanding and intervening with family and marital problems.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 554
Survey of Multivariate Statistics
Introduction to the major multivariate statistical procedures used in psychology; factor analysis, discriminant analysis, multivariate analysis of variance and canonical correlation.
Prerequisite(s): [(PSYC 545) OR (PSYC 546)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 555
Seminar in Industrial Training
Survey of various types of training and development programs used in industry. Also included are related major issues, specific techniques, assessment of training needs and evaluation of training programs.
Prerequisite(s): [(PSYC 529 and PSYC 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 556
Organizational Psychology
Theory and research concerning human behavior in formal organizations, communication nets, dynamics of managerial jobs; current ideas concerning organizations.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 557
Pre-Practicum in Rehabilitation and Mental Health Counseling
Study of the counseling process within a multicultural society. Includes essential interviewing and counseling techniques, counselor characteristics and behaviors, and ethical considerations in counseling with an orientation toward wellness and empowerment.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 558
Industrial Psychology Internship I
Supervised experience in psychological practices in an industrial setting. (Credit: variable)
Credit: Variable

PSYC 559
Industrial Psychology Internship II
Supervised experience in psychological practices in an industrial setting. (credit: Variable)
Credit: Variable

PSYC 561
Applied Counseling Techniques: Group Counseling
Methods and techniques in the group counseling process including group facilitation and leadership. Provides a theoretical and experiential understanding of group purpose, development, dynamics, theories, methods, skills, and other group approaches in a multicultural society with an emphasis on working with persons with disabilities within a family/systems framework.
Prerequisite(s): [(PSYC 523*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 562
Job Placement
Techniques of job development, job analysis, job placement, job seeking skills and follow-up. Includes affirmative action, manpower, and legislative programs involving job placement of special groups.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 563
Human Growth and Career Development
Presentation and discussion of human growth and career development theories across life span with special emphasis on persons with disabilities. Includes the nature and needs of persons at all developmental levels and in multicultural contexts with specific focus on biological bases of behavior, learning and personality development, transitioning, career decision making, and the family/system in?uences on vocational choice.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 564
Rehabilitation and Mental Health Counseling Research Seminar
The primary objective of this course is to help students become familiar with rehabilitation and mental health counseling research, acquire the basic knowledge and skills for designing and conducting applied research, and develop a preliminary research proposal for their research project. A secondary purpose is to teach students to critically evaluate rehabilitation and mental health counseling research in order to inform evidence-based practice. Includes an overview of various research designs, data analysis techniques, and the use of SPSS for statistical analysis as well as principles and models of program evaluation and the use of findings to effect program modifications.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 566
Addictive Behaviors and Principles of Behavior Change
A review of theoretical models of addiction and behavior from sociological, biological, and psychological perspectives. Critical examination of research methodology and empirically supported clinical approaches. Emphasis on substance and process addictions.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 571
Structural Equation Modeling
This is an introductory course to structural equation modeling (SEM). Following completion of this course, students should be able to (1) conduct analyses of measurement, structural, and full models, (2) model interactions in SEM, (3) understand how SEM can be used to model growth curves, (4) communicate results of SEM analyses in both written and oral form, and (5) critically evaluate the application of SEM in published research.
Prerequisite(s): [(PSYC 554)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 573
Psychosocial Bases: Disability and Behavior
Presentation and discussion of psychological and social issues of disability and human behavior. Somatopsychology, field integrative theories and psychological aspects of disabilities. Consent of instructor.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 575
Adult Career Development and Vocational Behavior
Presentation and discussion of impact of disabilities on adult career development. Vocational development theories, occupational information and analysis, career counseling and research methodology.Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 576
Research in Rehabilitation and Mental Health Counseling
This course teaches students to develop a preliminary research proposal for a research project based in areas of rehabilitation and mental health counseling. This course also prepares students for designing research investigations, collecting data sets, utilizing data analytic techniques, and interpreting empirical research.
Prerequisite(s): [(PSYC 564)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 577
Professional and Ethical Issues in Rehabilitation and Counseling
Presentation and discussion of issues related to professional and ethical practice in the fields of rehabilitation and counseling. History and philosophy of rehabilitation and counseling, professional and ethical standards, leadership and advocacy, concerns in rehabilitation assessment, counseling and related professional concerns, and placement and independent living.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 578
Rehabilitation and Mental Health Counseling Internship I
Supervised experience in rehabilitation and mental health counseling, which is intended to reflect the comprehensive work experience of a professional counselor. Students are provided the opportunity to become familiar with a variety of professional activities and resources in addition to direct service (e.g., record keeping, assessment instruments, supervision, information and referral, in-service, and staff meetings).
Prerequisite(s): [(PSYC 549)]
Credit: Variable

PSYC 579
Rehabilitation and Mental Health Counseling Internship II
Supervised experience in rehabilitation and mental health counseling, which is intended to reflect the comprehensive work experience of a professional counselor. Students are provided the opportunity to become familiar with a variety of professional activities and resources in addition to direct service (e.g., record keeping, assessment instruments, supervision, information and referral, in-service, and staff meetings).
Prerequisite(s): [(PSYC 549)]
Credit: Variable

PSYC 580
Seminar in Leadership
Reviews models and theories of leadership that cover group dynamics, power, influence, and conflict management as well as issues of diversity and gender. The focus is on research and practical issues in understanding leadership and its effectiveness. Requires certification as K-12 teacher or approval of instructor.
Prerequisite(s): [(PSYC 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 581
Neuropsychologicial Assessment
Seminar in neuropsychological assessment. A review of neuroanatomy followed with a review of the conceptual foundations of brain-behavior relationships. Major assessment instruments will be covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 582
Applied Psychophysiology and Biofeedback
Reviews applications of physiological measures to practical problems. Clinical applications of biofeedback are discussed and demonstrated. Special emphasis on electromyographic techniques.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 583
Rehabilitation Engineering Technology I: Survey of Interdisciplinary Application of RET
An overview of Assistive Technology (AT) used by people with disabilities. Includes contact with local AT sites, consumers and practicing professionals. Reviews specific AT applications for communication, mobility and control; national and local AT resources; and economics of AT development, marketing and service delivery. Design, engineering, and architectural issues relevant to people with disabilities are introduced.Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 584
Rehabilitation Engineering Technology II: Access to Independence Through Assistive Technology
Seminar designed for deeper exploration of Assistive Technology issues introduced in PSYC 583. Special focus on accessibility issues, technology outreach and awareness training; additional topics are chosen to reflect the specific interests of students in the class. Buildings are surveyed using ADAAG criteria for accessibility.
Prerequisite(s): [(PSYC 583)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 585
Rehabilitation Engineering Technology III
Seminar designed to accompany and enhance practical RET experiences, such as concurrent internship, employment or approved projects involving RET/AT applications. Case presentations of technology for independent living, issues of quality of outcome, alternatives/appropriateness of technology solutions, ethics, emotional aspects of technology acquisition, independence/dependency and barriers to acquiring and deployment of AT are discussed.
Prerequisite(s): [(PSYC 583 and PSYC 584)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 586
Concepts of Supervision
Explores formulations of the supervisory relationship and critical issues in the supervision of clinicians.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 588
Graduate Psychology Seminar
Reports and discussion of current problems and issues in psychology.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 589
Rehabilitation Internship III
Supervised experience in rehabilitation counseling. (Credit: Variable)
Prerequisite(s): [(PSYC 549)]
Credit: Variable

PSYC 590
Psychiatric Rehabilitation
Class covers a wide range of topics including a review of the disease and disability models of mental illness, skills training components in treatment, incentive strategies for participants, transfer of learned skills to other situations, and cognitive rehabilitation strategies.
Lecture: 3 **Lab:** 0 **Credits:** 3

PSYC 591
Research and Thesis M.S.
Instructor permission required.
Credit: Variable

PSYC 594
Special Projects
Instructor permission required.
Credit: Variable

PSYC 595
Graduate Research Project
Independent research for PhD students who are required to complete a thesis equivalent project. Instructor permission required.
Credit: Variable

PSYC 597
Special Problems
Instructor permission required.
Credit: Variable

PSYC 599
Clinical Internship
Ph.D. Comprehensive Exam Participation in full-time internship accredited by the American Psychological Association, or, in exceptional cases, approved by the clinical Psychology program. Approval of dissertation proposal and instructor permission required.
Lecture: 0 **Lab:** 0 **Credits:** 1

PSYC 600
Continuation of Residency
Continuation of residency.
Lecture: 0 **Lab:** 0 **Credits:** 1

PSYC 691
Research and Thesis Ph.D.
Research and thesis for Ph. D. students.
Credit: Variable

PSYC 710
Compensation and Benefit Application
Compensation and benefit application.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 711
Multilevel Data Analysis
Review of statistical methods for analysis of data at multiple levels of aggregation, such as individual and group-level phenomena. The course will cover conceptual issues, statistical models, and data analysis using computer software.
Lecture: 3 **Lab:** 0 **Credits:** 1.5

PSYC 712
Bayley Scales of Infant Development
Bayley Scales of Infant Development.
Lecture: 3 **Lab:** 0 **Credits:** 1

PSYC 714
Assessment Centers
This course will develop the knowledge and skills needed for the design and implementation of assessment centers and other individual assessment methods.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 715
Organizational Assessment and Planning
This short course focuses on various processes and tools used in organizations to assess effectiveness, establishing priorities, and creating plans of action for change. Topics include the strategic planning process and the development and use of assessment tools such as organizational surveys and focus groups. Requires basic knowledge of statistics.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 716
Base Pay Management
This course provides an in-depth discussion of the principles, design, implementation and evaluation of an employee base-pay program. Topics include concepts for determining market position using salary surveys, the design of base pay structures, principles of merit pay, and the ongoing management of base pay programs.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 717
Variable Pay Programs
This course provides an in-depth review of variable pay programs within organizations, including incentives, recognition programs and team-based pay. Organization-wide, organizational unit, and individual programs will be discussed in terms of plan design, implementation and evaluation.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 719
Fundamentals of Employee Benefits Programs
This course will address all aspects of employee benefits programs including government regulations, health and welfare plans, retirement plans and pay for time not worked. Case studies will be used to model real-life situations encountered by Human Resources professionals.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 720
Individual Assessment for Industrial/Organizational Psychology
This course is designed to teach students how to assess individuals for hire, promotion, and development. Students will develop a testing protocol including a structured interview, cognitive ability, and personality testing. The course will provide applied experience conducing assessments of executives who have volunteered to serve as testing subjects. Interviewing skill, test interpretation, and report writing are the primary learning objectives of the course.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 721
Network Analysis
Network analyses focuses on relationships between social entities (e.g. individuals, groups, businesses) and has been used in a number of fields including the social and behavioral sciences. The primary focus will center on social network analysis, which has been developed from an interdisciplinary approach from sociology, psychology, and economics. This course will present an introduction to various methods and concepts of social network analysis including applications in the social and behavioral sciences using these methods. Topics include, but are not limited to, graph theory, properties of individuals, subgroups/cliques, blockmodels, and dyad/triad analysis. An introduction to network models and applications in common software programs will also be given.
Prerequisite(s): [(PSYC 545 and PSYC 546)]
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 722
Consulting Fundamentals
The course will focus on identifying customer groups, developing products or services, pricing, proposal writing, and ethics in consulting.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 782
Assitive Technology for Counselors
Intensive one-week overview of Assistive Technology with a focus on vocational applications. Includes visitations to working assistive technology sites, and lectures by consumers and specialists (including several of national prominence) in various areas of AT. Instructor permission required.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PSYC 783
Vocational Applications of AT
Internet based distance class designed to follow PSYC 782 and further develop the student's knowledge of AT and the skill in applying AT to solve practical problems for persons with disabilities. Applies knowledge AT service delivery presented in PSYC 782 to issues in the student's local region. Identifies AT needs of persons with disabilities and weaknesses, strengths, and gaps in local region's AT service delivery, with emphasis on vocational applications. Instructor permission required.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

Bachelor of Science in Psychology/Master of Science in Personnel and Human Resources Development

For Illinois Institute of Technology undergraduate psychology majors it is possible to earn a Master of Science in Personnel and Human Resources Development in 1.5 years instead of the normal 2 years. The regular master's program in personnel and human resources development requires 43 credit hours post-bachelor's, usually completed over the course of 2 years (see program description (p. 352) in this bulletin). However, Illinois Institute of Technology psychology majors who meet the criteria for regular admission to the master's program can consider completing their master's degree more quickly by smart use of their electives. In the senior year, qualified students can take graduate courses to meet their undergraduate elective requirements. For a class to be accepted towards the PHRD master's, the student needs to obtain a grade of "B" or better. By taking psychology courses that also apply to the personnel and human resources development program, students can reduce the graduate degree requirements by 13 credit hours. Interested students should submit a formal application to the PHRD program in the fall of their sophomore or junior year and work closely with the head of the industrial/organizational program and their undergraduate academic adviser throughout to ensure proper course sequencing.

Curriculum

The following courses are required for the M.S. in Personnel and Human Resources Development. They can be taken as part of required or elective courses for the B.S. in Psychology. If taken as an undergraduate, these courses do not have to be repeated for the graduate program. Students should also work closely with their undergraduate academic adviser to best plan a program leading to the combined degrees in the shortest possible time.

In the senior year, and in consultation with the director of the industrial/organizational program, students may take the following courses:

PSYC 502	Social Bases of Behavior	3
or PSYC 504	Individual and Cultural Differences	
PSYC 529	Personnel Selection and Evaluation [1]	3
PSYC 545	Graduate Statistics I [1]	3
PSYC 546	Graduate Statistics II [1]	3
PSYC 556	Organizational Psychology [1]	3

1 Courses need to be taken in the senior year in order to accelerate completion of the master's degree.

In the summer, after completion of the B.S., students will be eligible to complete their first required graduate internship. This needs to be coordinated during the senior year and prior to the summer with the director of the industrial/organizational program.

Master of Science in Personnel and Human Resources Development

The M.S. in Personnel and Human Resources Development is designed for individuals who wish to work as applied professionals in areas such as management consulting, human resource management, industrial relations, and consumer behavior.

Curriculum

Core Courses			(18)
PSYC 511	Psychometric Theory		3
PSYC 529	Personnel Selection and Evaluation		3
PSYC 545	Graduate Statistics I		3
PSYC 546	Graduate Statistics II		3
PSYC 555	Seminar in Industrial Training		3
PSYC 556	Organizational Psychology		3
Internship Courses			(6)
Select 6 credit hours from the following:			6
PSYC 558	Industrial Psychology Internship I	1-6	
AND/OR			
PSYC 559	Industrial Psychology Internship II	1-6	
Elective Courses			(19)
Select 19 credit hours			19
Total Credit Hours			43

These core courses provide a broad understanding of human relations in the workplace through theory and practice. Electives in advanced general psychology, industrial/organizational psychology, vocational rehabilitation, public administration, law, and business allow for specialization. Designed as a two year full-time program with a minimum of 43 credit hours required, it also can be undertaken on a part-time basis. A research thesis or project is not required. Completing each I/O and statistics course with a minimum of a “B” (or appropriate remedial work determined by the department) constitutes the comprehensive requirement. There is no foreign language requirement.

Minimum requirements for admission include a bachelor’s degree from an accredited institution, a minimum undergraduate GPA of 3.1/4.0, GRE results, and favorable academic recommendations. Further information can be obtained from the program upon request.

Master of Science in Psychology

The M.S. in Psychology is exclusively a preliminary degree for students working toward a Ph.D. The aim is to evaluate and prepare students for work beyond the master of science.

Curriculum

Required Courses		(18)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Learning and Cognition	3
PSYC 504	Individual and Cultural Differences	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
Elective Courses		(8)
Select 8 credit hours		8
Thesis Research		(6)
PSYC 591	Research and Thesis M.S.	6
Total Credit Hours		32

This sequence constitutes the comprehensive requirement for the degree. Students must complete it with a minimum of a “B” average and no more than one “C” in these four core courses. Core courses must be completed within two years after the sequence is started.

The remaining courses are planned by the student and adviser according to the requirements of the student’s program area as noted below. No more than 12 credit hours may be taken below the 500-level. More detailed information concerning requirements for specialization in the areas of clinical or industrial/organizational psychology is available from the department.

Upon completion of the thesis, the student must satisfactorily complete an oral examination, which is limited to a defense of the thesis.

Additional courses for Clinical students

PSYC 510	Clinical Assessment I	3
PSYC 518	Basic Clinical Skills	1
PSYC 519	Therapy I-A	2
PSYC 526	Psychopathology	3
Total Credit Hours		9

Additional courses for I/O students

PSYC 529	Personnel Selection and Evaluation	3
PSYC 556	Organizational Psychology	3
Select one elective		3
Total Credit Hours		9

Master of Science in Rehabilitation and Mental Health Counseling

The rehabilitation and mental health counseling program, fully accredited by the Council on Rehabilitation Education (CORE) since 1975, and dually accredited by the Council for Accreditation of Counseling and Related Programs (CACREP), is designed to prepare students to function as rehabilitation and/or clinical mental health counselors for persons with a variety of needs including mental health issues impacting the individual and/or family, and persons with physical or mental disabilities to address psychosocial and vocational adjustment. The program is grounded in a strengths-based philosophy of client empowerment where the counselor's role is to assist individuals to realize their optimum level of mental health and personal wellness, including vocational adjustment and independent living. This is done through the use of a variety of therapeutic interventions, including individual, group and/or family counseling, diagnosis, case management, the provision or coordination of evaluation, physical restoration, training, placement, and follow-up services. The demand for rehabilitation and clinical mental health counselors has exceeded the supply in recent years in public, private, nonprofit, and for-profit sectors.

A core of required graduate courses provides the basic knowledge and skills necessary to the fields of rehabilitation and mental health counseling. These include counseling theory, rehabilitation and mental health counseling principles and practices with an emphasis on psychiatric rehabilitation, individual and group counseling, assessment in rehabilitation and mental health counseling, diagnosis of mental disorders, evidence-based treatment of mental disorders, job placement, medical and psychosocial aspects of disability, human growth, career development, and research methods.

Concurrently, field work of progressively increasing complexity takes place at a variety of community-based mental health and rehabilitation sites in the Chicago area. These include mental health and counseling centers, community rehabilitation facilities, the state department of vocational rehabilitation, rehabilitation centers, mental health centers, medical hospitals, and other facilities for persons with mental health concerns and/or disabilities.

This is a two-year, 60 credit hour program.

Curriculum

Required Courses		(42)
PSYC 410	Introduction to Rehabilitation and Mental Health Counseling	3
PSYC 411	Medical Aspects of Disabling Conditions	3
PSYC 412	Multicultural and Psychosocial Issues in Rehabilitation and Mental Health Counseling	3
PSYC 513	Assessment in Rehabilitation and Mental Health Counseling	3
PSYC 523	Introduction to Theories of Psychotherapy	3
PSYC 526	Psychopathology	3
PSYC 547	Evidence-Based Practice in Rehabilitation and Mental Health Counseling	3
PSYC 557	Pre-Practicum in Rehabilitation and Mental Health Counseling	3
PSYC 561	Applied Counseling Techniques: Group Counseling	3
PSYC 562	Job Placement	3
PSYC 563	Human Growth and Career Development	3
PSYC 564	Rehabilitation and Mental Health Counseling Research Seminar	3
PSYC 583	Rehabilitation Engineering Technology I: Survey of Interdisciplinary Application of RET	3
PSYC 590	Psychiatric Rehabilitation	3
Community-Based Clinical Experience		(15)
PSYC 549	Practicum in Rehabilitation and Mental Health Counseling	3
PSYC 578	Rehabilitation and Mental Health Counseling Internship I	6
PSYC 579	Rehabilitation and Mental Health Counseling Internship II	6
Research Project		(3)
PSYC 594	Special Projects	3
or PSYC 576	Research in Rehabilitation and Mental Health Counseling	
Total Credit Hours		60

For individuals currently working in the rehabilitation and mental health counseling field who are interested in pursuing a M.S. in Rehabilitation and Mental Health Counseling at a slower pace, there is a part-time option available which is designed to meet the needs of the working professional. Courses are generally offered in the evening and via distance education, and the required fieldwork experiences (practicum and internship) are typically worked out with the student's place of employment if it meets fieldwork site requirements. The part-time program takes approximately three years to complete.

There are opportunities to apply for scholarships and traineeships, including the Rehabilitation Services Administration (RSA) traineeships awarded based on commitment to working in the state/federal vocational rehabilitation (VR) system, academic performance, and economic need.

Master of Science in Rehabilitation and Mental Health Counseling with Advanced Standing

45-60 credit hours
Project

Candidates who hold a B.A. or B.S. in Psychology or other relevant degree or international students holding a relevant professional degree from outside the U.S. and who have completed the equivalent of the first semester's required courses may qualify for up to 15 credit hours of advanced standing in the Master of Science in Rehabilitation and Mental Health Counseling program.

Admission with advanced standing may allow the candidate to complete the Master of Rehabilitation and Mental Health Counseling degree in one-and-a-half years (three semesters), depending on prior preparation. The regular master's program in rehabilitation and mental health counseling requires 60 credit hours post-bachelor's usually completed over the course of two years. However, applicants who meet the admissions requirements and already have some qualifying graduate-level coursework may be eligible for advanced standing. In addition, Illinois Institute of Technology undergraduate students who meet the criteria for regular admission to the master's program can consider completing their master's degree more quickly by smart use of their electives. In the junior and senior years, qualified students can take graduate courses in RMHC to meet their undergraduate elective requirements.

For a course to be accepted towards advanced standing, the student needs to obtain a grade of "B" or better. Candidates may be asked to provide additional evidence on their previous coursework, including projects and course syllabi, to determine eligibility for advanced standing. Candidates will be notified upon admission as to their acceptance of advanced standing.

Interested students should speak to their undergraduate advisers in the fall of their sophomore or junior year and work closely with the head of the division of counseling and rehabilitation science throughout to ensure proper course sequencing.

Curriculum

The following courses may be considered towards advanced standing in the M.S. in Rehabilitation and Mental Health Counseling. They can be taken as part of required or elective courses for the B.S. in Psychology at Illinois Institute of Technology. If taken as an undergraduate, these courses do not have to be repeated for the graduate program. Students should also work closely with their undergraduate academic adviser to best plan a program leading to the combined degrees in the shortest possible time. In the junior and senior year, and in consultation with the head of the division of counseling and rehabilitation science, students may take the following courses:

PSYC 410	Introduction to Rehabilitation and Mental Health Counseling	3
PSYC 411	Medical Aspects of Disabling Conditions	3
PSYC 412	Multicultural and Psychosocial Issues in Rehabilitation and Mental Health Counseling	3
PSYC 513	Assessment in Rehabilitation and Mental Health Counseling	3
PSYC 523	Introduction to Theories of Psychotherapy	3
PSYC 562	Job Placement	3
PSYC 563	Human Growth and Career Development	3
PSYC 564	Rehabilitation and Mental Health Counseling Research Seminar	3
PSYC 583	Rehabilitation Engineering Technology I: Survey of Interdisciplinary Application of RET	3
PSYC 590	Psychiatric Rehabilitation	3

Except as noted above, the requirements for this degree are the same as the Master of Science in Rehabilitation and Mental Health Counseling (p. 354).

Doctor of Philosophy in Psychology with Specialization in Clinical Psychology

107 credit hours minimum
Comprehensive exam
Dissertation and oral defense
Internship (1 year, full-time)

The Ph.D. program with specialization in clinical psychology is accredited by the American Psychological Association. Completion typically requires six to seven years of study beyond the bachelor's degree, including a one year full-time internship. Students with prior graduate work may receive advanced credit. The program follows the scientist-practitioner model and emphasizes an integration of clinical practice and applied clinical research. Working with a faculty mentor, students begin research work their first year. Students complete three years of 15-20 hour/week practicum training that includes a wide variety of assessment and treatment experiences with a broad range of clients, including minority and underserved populations. Training sites include medical centers, community mental health centers, and clinics throughout the Chicago metropolitan area. Clinical supervision is provided both on-site and at the university. All students complete an APA-accredited internship. The program prepares students to be license-eligible in the state of Illinois and most other states. Graduates typically function as practitioners and researchers in medical centers and multi-disciplinary clinical settings.

Students may elect to further specialize in the rehabilitation track. This specialization requires practica in a rehabilitation-related setting. In addition, students complete their five elective seminars in the rehabilitation program curriculum and their research with rehabilitation program faculty. The specialization in the rehabilitation track occurs along with the standard program of the clinical specialization.

Curriculum

Doctor of Philosophy in Psychology Common Requirements

All Ph.D. students must complete the sequence of PSYC 501, PSYC 502, PSYC 503, and PSYC 504 with a minimum of "B" average and no more than one "C" in these four courses.

All students are expected to show competency in methodology and research design, as well as in the specific content of their program areas. Before beginning dissertation research, a student must present a dissertation proposal for approval by a committee of the faculty. The final requirement of the Ph.D. program is an oral examination restricted to defense of the dissertation and conducted by a committee nominated by the department and appointed by the Dean of Graduate Studies.

Specialization in Clinical Psychology Requirements

Foundational Courses		(27)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Learning and Cognition	3
PSYC 504	Individual and Cultural Differences	3
PSYC 505	History and Systems of Psychology	3
PSYC 540	Research Methods	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
PSYC 554	Survey of Multivariate Statistics	3
Base Clinical Courses		(12)
PSYC 508	Ethics and Professional Issues I	2
PSYC 509	Ethics and Professional Issues II	1
PSYC 523	Introduction to Theories of Psychotherapy	3
PSYC 525	Developmental Psychopathology	3
PSYC 526	Psychopathology	3
Clinical Practice Courses		(18)
PSYC 506	Therapy I	3
PSYC 507	Therapy II	3
PSYC 510	Clinical Assessment I	3
PSYC 512	Clinical Assessment II	3
PSYC 533	Clinical Practicum	4
PSYC 599	Clinical Internship	2

Elective Courses		(15)
Some offerings in recent years: health psychology, affective disorders, neuropsychological assessment, eating and weight disorders, assessment and treatment of young children, child cognitive development, psychology of sport, performance and health, structural equation modeling psychometric theory, hierarchical linear models.		15
Research Courses		(35)
PSYC 591	Research and Thesis M.S.	6
PSYC 597	Special Problems	5
PSYC 691	Research and Thesis Ph.D.	24
Total Credit Hours		107

Doctor of Philosophy in Psychology with Specialization in Industrial/Organizational Psychology

96 credit hours minimum
Comprehensive exam
Dissertation and oral defense
Internship

The Ph.D. program in industrial/organizational psychology includes coursework in both personnel and organizational psychology. Two semesters of internship in an organizational setting are required. Students in this program frequently are advised to supplement departmental offerings with selected courses in management or other related fields.

Curriculum

Doctor of Philosophy in Psychology Common Requirements

All Ph.D. students must complete the sequence of PSYC 501, PSYC 502, PSYC 503, and PSYC 504 with a minimum of “B” average and no more than one “C” in these four courses.

All students are expected to show competency in methodology and research design, as well as in the specific content of their program areas. Before beginning dissertation research, a student must present a dissertation proposal for approval by a committee of the faculty. The final requirement of the Ph.D. program is an oral examination restricted to defense of the dissertation and conducted by a committee nominated by the department and appointed by the Dean of Graduate Studies.

Specialization in Industrial and Organizational Psychology Requirements

Required Courses			(39)
PSYC 501	Biological Bases of Behavior		3
PSYC 502	Social Bases of Behavior		3
PSYC 503	Learning and Cognition		3
PSYC 504	Individual and Cultural Differences		3
PSYC 511	Psychometric Theory		3
PSYC 529	Personnel Selection and Evaluation		3
PSYC 545	Graduate Statistics I		3
PSYC 546	Graduate Statistics II		3
PSYC 554	Survey of Multivariate Statistics		3
PSYC 555	Seminar in Industrial Training		3
PSYC 556	Organizational Psychology		3
PSYC 558	Industrial Psychology Internship I		3
PSYC 559	Industrial Psychology Internship II		3
Elective Courses			(25-27)
Select 25-27 credit hours from the following:			25-27
PSYC 517	Performance Appraisal Seminar	3	
PSYC 530	Contemporary Issues in Industrial Organizational Psychology	3	
PSYC 531	Organizational Attitudes and Behavioral Seminar	3	
PSYC 535	Seminar in Personnel Selection	3	
PSYC 540	Research Methods	3	

PSYC 552	Legal Issues in Human Resource Management	3
PSYC 571	Structural Equation Modeling	3
PSYC 580	Seminar in Leadership	3
PSYC 588	Graduate Psychology Seminar	3
PSYC 711	Multilevel Data Analysis	1.5
PSYC 714	Assessment Centers	1.5
Courses may also be selected from Stuart School of Business offerings		
Research Courses		(30-32)
PSYC 591	Research and Thesis M.S.	6-8
PSYC 691	Research and Thesis Ph.D.	24

Minimum degree credits required: 96

Doctor of Philosophy in Psychology with Specialization in Rehabilitation Counseling Education

96 credit hours minimum
Comprehensive exam
Dissertation and oral defense

The curriculum for the Ph.D. program with specialization in rehabilitation counseling education includes core counseling courses (e.g., individual and group counseling theories and microskills), and rehabilitation-specific coursework (e.g., vocational counseling and evaluation, job placement, medical and psychosocial aspects of disability), which provide the basic knowledge and skills necessary to rehabilitation counseling practice. Practicum and internships are taken at rehabilitation and social service agencies in the Chicago area.

Curriculum

Doctor of Philosophy in Psychology Common Requirements

All Ph.D. students must complete the sequence of PSYC 501, PSYC 502, PSYC 503, and PSYC 504 with a minimum of “B” average and no more than one “C” in these four courses.

All students are expected to show competency in methodology and research design, as well as in the specific content of their program areas. Before beginning dissertation research, a student must present a dissertation proposal for approval by a committee of the faculty. The final requirement of the Ph.D. program is an oral examination restricted to defense of the dissertation and conducted by a committee nominated by the department and appointed by the Dean of Graduate Studies.

Specialization in Rehabilitation Counseling Education Requirements

Psychological Foundations		(15)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Learning and Cognition	3
PSYC 504	Individual and Cultural Differences	3
PSYC 505	History and Systems of Psychology	3
Statistics and Research Design		(12)
PSYC 540	Research Methods	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
PSYC 554	Survey of Multivariate Statistics	3
Rehabilitation Core		(9)
PSYC 573	Psychosocial Bases: Disability and Behavior	3
PSYC 575	Adult Career Development and Vocational Behavior	3
PSYC 577	Professional and Ethical Issues in Rehabilitation and Counseling	3
Experiential Components of Rehabilitation		(9)
PSYC 586	Concepts of Supervision	3
PSYC 597	Special Problems	6
Minor		(12)

In consultation with their academic adviser, students can select from among four minor tracks including Rehabilitation Technology, Psychiatric Rehabilitation Administration, Organizational Psychology, and Clinical Psychology		12
Elective Courses		(15)
Select 15 credit hours		15
Research Courses		(24)
PSYC 691	Research and Thesis Ph.D.	24
Total Credit Hours		96

Rehabilitation Technology Minor Electives

PSYC 456	Engineering Psychology	3
PSYC 583	Rehabilitation Engineering Technology I: Survey of Interdisciplinary Application of RET	3
PSYC 584	Rehabilitation Engineering Technology II: Access to Independence Through Assistive Technology	3
PSYC 585	Rehabilitation Engineering Technology III	3
PSYC 589	Rehabilitation Internship III	1-6

Psychiatric Rehabilitation Minor Electives

PSYC 548	Vocational Psychiatric Rehabilitation	3
PSYC 561	Applied Counseling Techniques: Group Counseling	3
PSYC 566	Addictive Behaviors and Principles of Behavior Change	3
PSYC 578	Rehabilitation and Mental Health Counseling Internship I	1-6
PSYC 579	Rehabilitation and Mental Health Counseling Internship II	1-6
PSYC 590	Psychiatric Rehabilitation	3
PSYC 597	Special Problems	1-20

Rehabilitation Administration and Organizational Psychology Minor Electives

PSYC 529	Personnel Selection and Evaluation	3
PSYC 547	Evidence-Based Practice in Rehabilitation and Mental Health Counseling	3
PSYC 556	Organizational Psychology	3
PA 552	Human Services Policy and Administration	3

Clinical Psychology Minor Electives

PSYC 510	Clinical Assessment I	3
PSYC 519	Therapy I-A	2
PSYC 520	Health Psychology	3
PSYC 526	Psychopathology	3

Certificate in Psychiatric Rehabilitation

Curriculum

Required Courses			(9)
PSYC 526	Psychopathology		3
PSYC 588	Graduate Psychology Seminar		3
PSYC 590	Psychiatric Rehabilitation		3
Total Credit Hours			9

Certificate in Rehabilitation Counseling

Curriculum

Required Courses			(16-21)
PSYC 410	Introduction to Rehabilitation and Mental Health Counseling		3
PSYC 513	Assessment in Rehabilitation and Mental Health Counseling		3
Select one course from the following:			3
PSYC 523	Introduction to Theories of Psychotherapy	3	
PSYC 557	Pre-Practicum in Rehabilitation and Mental Health Counseling	3	
Select one course from the following:			3
PSYC 562	Job Placement	3	
PSYC 563	Human Growth and Career Development	3	
PSYC 575	Adult Career Development and Vocational Behavior	3	
Select one course from the following:			3
PSYC 411	Medical Aspects of Disabling Conditions	3	
PSYC 588	Graduate Psychology Seminar	3	
Select one course from the following:			1-6
PSYC 578	Rehabilitation and Mental Health Counseling Internship I	1-6	
PSYC 599	Clinical Internship	1-6	

Minimum certificate credits required: 21

Certificate in Rehabilitation Engineering Technology

Curriculum

Required Courses		(9)
PSYC 583	Rehabilitation Engineering Technology I: Survey of Interdisciplinary Application of RET	3
PSYC 584	Rehabilitation Engineering Technology II: Access to Independence Through Assistive Technology	3
PSYC 585	Rehabilitation Engineering Technology III	3
Total Credit Hours		9

School of Applied Technology

C. Robert Carlson
Dean
10 W. 33rd St.
Perlstein Hall 223
Chicago, IL 60616
312.567.5290

Daniel F. and Ada L. Rice Campus
201 East Loop Road
Wheaton, IL 60187
630.682.6000
appliedtech.iit.edu

The School of Applied Technology (SAT), established in 2010, was formed to prepare students to become innovators, entrepreneurs, and leaders of the future. Programs and courses at the School of Applied Technology provide a blend of theoretical content and practical application that utilize a hands-on, reality-based approach to education. The degree and certificate programs provide an innovative experience where students work on cutting-edge, industry-sponsored projects, allowing students to apply what they learn in class to solve real-life problems.

SAT offers bachelor's and master's degrees from the Department of Information Technology and Management in information technology and management and in cyber forensics and security; master's degrees from the Department of Food Science and Nutrition in food process engineering and food safety and technology; and bachelor's and master's degrees from the Department of Industrial Technology and Management in industrial technology and management.

SAT is affiliated with the renowned Institute for Food Safety and Health and hosts the Center for Cyber Security and Forensics Education (C2SAFE) and the Center for Innovation Science and Applications.

In addition to degree-seeking programs, the School of Applied Technology, through its Office of Professional Development and IIT Online, combines university-wide resources to establish a common administration and support structure for online and non-degree programs. Programs include: university-wide ESL assessment and instruction, technology-oriented training and certificates, employee and professional development, and short courses and seminars.

Department of Food Science and Nutrition

Degree Programs

- Master of Food Process Engineering (p. 368)
- Master of Food Safety and Technology (p. 369)
- Master of Food Safety and Technology with Specialization in Business (p. 369)
- Master of Food Safety and Technology with Specialization in Industrial Management (p. 369)
- Master of Science in Food Process Engineering (p. 370)
- Master of Science in Food Safety and Technology (p. 371)
- Doctor of Philosophy in Food Science and Nutrition (p. 372)

Certificates

- Food Process Engineering (p. 374)
- Food Processing Specialist (p. 374)
- Food Safety and Industrial Management (p. 375)
- Food Safety and Technology (p. 375)

Department of Industrial Technology and Management

Degree Program

- Master of Industrial Technology and Operations (p. 380)

Department of Information Technology and Management

Degree Programs

Certificates

Food Science and Nutrition

Institute for Food Safety and Health
Moffett Campus
6502 S. Archer Road Bedford Park, IL 60501
708.563.8271
708.563.8274 (fax)
iit.edu/ifsh

Illinois Institute of Technology Vice President, IFSH Director, and Interim Chair
Robert Brackett

IFSH Associate Director, Professor, and Associate Chair
Jason Wan

Graduate Program Manager
Renee McBrien

Faculty with Research Interests
For more information regarding faculty visit the Department of Food Science and Nutrition website.

The Department of Food Science and Nutrition (FdSN) at the School of Applied Technology and the Institute for Food Safety and Health (IFSH), with Illinois Institute of Technology faculty, U.S. Food and Drug Administration (FDA) scientists, and food industry experts, provides a unique training ground for individuals seeking graduate education in food safety and technology and food process engineering.

The master's degree programs in food safety and technology (FST) and food process engineering (FPE) are designed to educate food technologists and engineers in aspects relating to food processing and safety. Students can specialize in food processing and packaging, food microbiology and safety, compositional safety of food (chemistry), and food for health (nutrition). Graduates of the program will be prepared to assume responsible positions in food manufacturing operations, research and development, food safety, compliance and regulatory affairs, and quality assurance in the processing, retail, and food service segments of the food industry. Other career options include positions with federal, state, or local health and agri-food agencies, and in policy-making, regulatory, or research roles with organizations associated with food manufacturing operations.

Facilities

The IFSH facilities include 40,000 square feet of research laboratories, office and meeting space, 26,000 square feet of industrial scale pilot plant facility, 3,000 square feet of food processing plant (GMP) and 3,000 square feet of Biosafety Level-3 (BSL-3) Laboratory and Bio-containment Pilot Plant (BCPP). The research laboratory facilities at Moffett Campus include numerous laboratories for microbiology, virology, molecular biology, chemistry, biochemistry, nutrition, and engineering. A 5,000 square feet Clinical Nutrition Research Facility is also located at the university's Mies Campus. The pilot plant at IFSH houses state of the art equipment such as computer-controlled retorts, high temperature-short time plate pasteurizer, high pressure food processors for pasteurization and sterilization studies, equipment for aseptic processing of particulate foods, pulsed electric field apparatus, ozone processor, UV food processors, homogenizers, and high power ultrasound. The BSL-3 and BCPP provide an opportunity to conduct studies on control of pathogenic microorganisms using pilot-scale equipment. Further, microbiological, food engineering, chemical, and packaging laboratories support the pilot plant facilities. IFSH's food science and technology library provides both physical and systems access to current and retrospective research and technical publications. The 25,000 square feet of laboratories and facilities of the FDA Division of Food Processing Science and Technology physically located in the same building are also available to FdSN collaborative research projects.

Admission Requirements

- Bachelor's degree in chemistry; biology; food science; nutrition; or chemical, agricultural, food or environmental engineering; or a related field.
- Cumulative undergraduate GPA minimum: 3.0/4.0

1. GRE of 304 (verbal and quantitative) for Master of Science in Food Safety and Technology or Food Process Engineering
2. GRE of 295 for Master of Food Safety and Technology, Master of Food Safety and Technology with Specialization in Business, Master of Food Safety an
   Students applying for the master's academic program (non-thesis option) with an undergraduate degree from a major U.S. university with a cumulative GPA of 3.0/4.0 or higher may not be required to submit a GRE score.
3. TOEFL minimum: 550/213/80 (paper-based/computer-based test score)

Note: Certificate programs do not require GRE and TOEFL scores.

Degrees Offered

Certificate Programs

Course Descriptions

FDSN 501
Nutrition, Metabolism, and Health
Study of chemical structures, types, and metabolism of carbohydrates, lipids, and proteins. Discussion of the biological and chemical roles of vitamins and minerals. Application and integration of metabolic knowledge with health promotion and chronic disease.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 502
Development, Delivery, and Dissemination
This course is an introduction to writing and presenting on scientific research with a focus on skills necessary for research at IIT's Institute for Food Safety and Health. Topics will include defining a problem, structuring a literature review, creating a research proposal, and written and oral presentation of research results.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 504
Food Biotechnology
Introduction of biotechnology in the food industry including genetic engineering of microorganisms. Fundamentals of microbial genomics and proteomics. Practice of a variety of software and bioinformatics tools including database search, sequence alignment, phylogenetic and cluster analyses, gene production, genomic map construction, and structural and functional prediction of proteins. Applications of DNA fingerprinting techniques in food safety and public health.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 505
Food Microbiology
Principles of occurrence and control. Importance of sanitation and prevention of public health problems. Microbiological contaminants and methods for their detection. Mechanisms of microbial inactivation.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 506
Food Microbiology Laboratory
Introductory Microbiology. Basic microbiological techniques and safe laboratory practices. Introductory Food Microbiology. Isolation pathogenic bacteria. Spoilage microorganisms. Fermentation. Environmental Monitoring. Rapid Identification tests. Sporeformers.
Lecture: 0 **Lab:** 3 **Credits:** 3

FDSN 507
Food Analysis
Techniques for analyzing food toxins, food constituents of public health concern, intentional and unintentional food additives, modern separation and analytic techniques.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 508
Food Product Development
Students in this class will learn how to do the following: identify the key steps in the food product development process and stage gate concepts; develop a formulation approach with ability to effectively understand how to work well with vendors, handle labeling regulations, food safety, and consumer acceptability requirements; create a product unit costing with trade-offs and contingencies for market launch; identify key performance requirements for product shelf life testing and packaging specifications; evaluate product quality and safety with traditional and state of the art assessment tools; how to conduct consumer tests, plant trials, and introduce new products and processes into the manufacturing operation and contingency planning; and develop a strategy to monitor and improve product performance.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 509
Fundamentals of Biostatistics and Epidemiology in Food Science and Nutrition
This course covers fundamental concepts in biostatistics and epidemiology with an emphasis on applications to food science, food safety, and nutrition. The course will emphasize study designs and epidemiologic and statistical methods used to investigate the relationships between health-related variables with particular attention to food-related exposures in health and disease.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 511
Food Law and Regulations
Legal and scientific issues in regulating the nation's food supply and nutritional status. Roles of regulatory agencies; Federal Food, Drug and Cosmetic Act; definitions and standards for food and adulterated foods. Manufacturing processed foods in compliance with regulations.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 520
Low-Acid Canned Food Regulations and Microbiology
Regulatory requirements for the U. S. Food and Drug Administration and the broad microbial issues associated with low-acid canned foods (LACF) products. Topics will include the U. S. Food Drug & Cosmetic (FD&C) Act, Emergency Permit Control, 21 Code of Federal Register (CFR) parts 108, 113, and 114, record requirements, sources of microbial contamination, characteristics of clostridium botulinum, mesosphelic sporeformers, indicator organisms, and introduction to microbial heat resistance.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 521
Food Process Engineering
Food engineering fundamentals, heat transfer in food processing, food rheology, freezing of foods, food dehydration, kinetics of chemical reactions in foods, refrigeration and thermal process calculations, and alternative methods of food processing.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 522
Advanced Food Process Engineering
Process calculations for food processing methods such as canning, aseptic processing, ohmic heating, microwave processing and pulsed energy processing. Extrusion techniques in food processing. Discussion of new food processing techniques and safety implications.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 523
Food Engineering Process Delivery
Requirements for the U. S. Food and Drug Administration food canning regulations, including system design, process establishment, operational, and inspection records. Operations and calibration requirements of thermal processing equipment. Process design, documentation of process deviation, and calculation of process delivery.
Prerequisite(s): [(FDSN 522)]
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 524
Fundamentals of Food Science
This course will cover the central food science issues encountered with storage and processing of all major American food commodities including meats, grains, confections, vegetables, eggs, and dairy. It will also review the relevant chemistry, physics, and engineering required to understand common food-related unit operations such as drying, freezing, sterilization, and radiation treatment of foods. An introduction to microbial and chemical issues of food quality and safety will also be covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 526
Engineering Principles of Food
Methods for conducting seal integrity examinations, spoilage diagnosis, and traceability, defining and classifying package defects. Types of packaging materials, including metal, glass, plastics, flexible and composite containers, and their closure and sealing systems. Aseptic and alternative process delivery systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 531
HACCP Planning and Implementation
Examination of the Hazard Analysis and Critical Control Point (HACCP) principles; microbiological and process overviews; generic HACCP models, Good Manufacturing Practices (GMP); monitoring of critical control points (CCPs), process control and implementation.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 541
Principles of Food Packaging
Type and application of packaging materials. Migration theories and food package interaction, package testing to ensure safety, and recycling of package materials.
Lecture: 3 **Lab:** 0 **Credits:** 3

FDSN 591
Research and Thesis
Research and Thesis for Master of Science Degree students.
Credit: Variable

FDSN 593
Seminar on Food Safety and Technology
Students attend seminars offered during the semester. Each student is also required to give a 30 minute presentation on a topic of his/her interest or a research project on which she/he has worked.
Lecture: 0 **Lab:** 0 **Credits:** 1

FDSN 594
Special Projects
Advanced projects in food processing and packaging, food microbiology and safety, food chemistry, and nutrition.
Credit: Variable

FDSN 597
Special Problems
Independent study of advanced topics in food science and nutrition including food processing and packaging, food microbiology and safety, food chemistry, and nutrition.
Credit: Variable

FDSN 600
Continuing of Residence
Continuing of residence.
Lecture: 0 **Lab:** 0 **Credits:** 1

FDSN 610
Advanced Topics in Food Microbiology
This course is an advanced course in food safety microbiology covering the latest development and trends in food safety related microbiology, including emerging foodborne pathogens of public health significance, as well as the use of the latest technologies for the detection and control of these microbial food safety hazards. This course can be used as credits towards candidature for a Ph.D. degree in Food Safety and Technology/Food Science and Nutrition.
Lecture: 2 **Lab:** 0 **Credits:** 2

FDSN 620
Advanced Topics in Food Chemistry
This course can be used as credits towards candidature for a Ph.D. degree in Food Science and Nutrition. This course is expected to cover advanced knowledge in the chemistry of the components of foods, their physiochemical properties and chemical interactions, and the chemical changes that occur during processing, storage, and packaging. Students are expected to work on evidence derived from original research literature, interpretation of research findings, and problem solving based on the scientific principles of food chemistry. This advanced program is open to individuals who hold undergraduate degrees in chemistry, food science, or related disciplines. Students who have completed the FDSN 524 Fundamentals of Food Science and Technology and FDSN 507 Food Analysis courses with a B or higher may also apply. Upon successful completion of this course, students are expected to be able to translate theory and research into practice.
Lecture: 2 **Lab:** 0 **Credits:** 2

FDSN 630
Advanced Topics in Nutrition
This course can be used as credits towards candidature for a Ph.D. degree in Food Science and Nutrition. This course is expected to cover advanced knowledge in nutrition, metabolism, disease prevention and health promotion. This advanced program is open to individuals who hold undergraduate degrees in nutritional science, food science, health science, biology, biochemistry, chemistry or related disciplines. Students who have completed the FDSN 501 course with a B or higher may also apply. Upon successful completion of this course, students are expected to be able to translate theory and research into practice.
Lecture: 2 **Lab:** 0 **Credits:** 2

FDSN 640
Advanced Topics in Food Process Engineering
This course covers recent advancements and developments in food engineering and food processing including novel and emerging processing technologies, advanced thermal process calculations, modeling, simulation, sustainable food processing, process controls & automation and kinetics of food transformations, energy reduction, and food rheology. This course can be used towards candidature for a Ph.D. degree in Food Safety and Technology/Food Science and Nutrition.
Lecture: 2 **Lab:** 0 **Credits:** 2

FPE 593
Seminar on Food Safety and Technology
Students attend seminars offered during the semester. Each student is also required to give a 30 minute presentation on a topic of his/her interest or a research project on which she/he has worked. (Credit: 1 Hour)
Lecture: 0 **Lab:** 0 **Credits:** 1

FST 526
Engineering Properties of Food
Study of physical, thermal, and electrical properties of food and biological materials. Importance in process design. Methods for property measurement.
Lecture: 3 **Lab:** 0 **Credits:** 3

FST 593
Seminar on Food Safety and Technology
Students attend seminars offered during the semester. Each student is also required to give a 30 minute presentation on a topic of his/her interest or a research project on which she/he has worked. (Credit: 1 Hour)
Lecture: 0 **Lab:** 0 **Credits:** 1

Master of Food Process Engineering

Curriculum

Candidates are required to take a total of 32 credit hours, 18 of which must be from the core courses listed below, 8-9 credit hours must be selected from FdSN elective courses, and 5-6 credit hours must be selected from the Department of Chemical and Biological Engineering courses. Courses are offered at the Illinois Institute of Technology Mies Campus or via internet with the exception of FDSN 506.

Core Courses			(18)
FDSN 505	Food Microbiology		3
FDSN 506	Food Microbiology Laboratory [1]		3
FDSN 521	Food Process Engineering		3
FDSN 522	Advanced Food Process Engineering		3
FDSN 524	Fundamentals of Food Science		3
FDSN 541	Principles of Food Packaging		3
Electives			(13-15)
Select a minimum of two courses from the following:			8-9
FDSN 501	Nutrition, Metabolism, and Health	3	
FDSN 502	Development, Delivery, and Dissemination	3	
FDSN 504	Food Biotechnology	3	
FDSN 507	Food Analysis	3	
FDSN 508	Food Product Development	3	
FDSN 511	Food Law and Regulations	3	
FDSN 520	Low-Acid Canned Food Regulations and Microbiology	3	
FDSN 523	Food Engineering Process Delivery	3	
FDSN 526	Engineering Principles of Food	3	
FDSN 531	HACCP Planning and Implementation	3	
FDSN 593	Seminar on Food Safety and Technology	1	
FDSN 594	Special Projects [2]	1-6	
FDSN 597	Special Problems [2]	1-6	
Select at minimum of two courses from the following:			5-6
CHE 426	Statistical Tools for Engineers	3	
CHE 439	Numerical and Data Analysis	3	
CHE 494	Process Design I	3	
CHE 560	Statistical Quality and Process Control	3	
CHE 577	Bioprocess Engineering	3	
ENVE 513	Biotechnological Processes in Environmental Engineering	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	

Minimum degree credits required: 32

1. FDSN 506 is required unless the student has enough professional experience to allow a substitute class; the decision will be made by the FdSN program director.
2. Students can enroll in FDSN 594 and FDSN 597 with a maximum of 6 credit hours total between both courses with FdSN adviser approval. However, when FDSN 597 is used as a short course, the total credit hours must not exceed 8 between FDSN 594 and FDSN 597.

Students may enroll in a ChBE course that is not listed above, with FdSN adviser approval.

Master of Food Safety and Technology

Curriculum

Candidates are required to take a total of 32 credit hours, 18 credit hours of which must be selected from the core food safety and technology courses listed below, and 14-17 credit hours must be selected from electives. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Core Course			(18)
FDSN 505	Food Microbiology		3
FDSN 506	Food Microbiology Laboratory		3
FDSN 507	Food Analysis		3
FDSN 521	Food Process Engineering		3
FDSN 524	Fundamentals of Food Science		3
FDSN 541	Principles of Food Packaging		3
Electives			(14-17)
Select 14-17 credit hours			14-17
FDSN 501	Nutrition, Metabolism, and Health	3	
FDSN 502	Development, Delivery, and Dissemination	3	
FDSN 504	Food Biotechnology	3	
FDSN 508	Food Product Development	3	
FDSN 511	Food Law and Regulations	3	
FDSN 522	Advanced Food Process Engineering	3	
FDSN 531	HACCP Planning and Implementation	3	
FDSN 593	Seminar on Food Safety and Technology	1	
FDSN 594	Special Projects	1-6	
FDSN 597	Special Problems	1-6	

Minimum degree credits required: 32

[1] Required unless the student has enough professional background or laboratory experience to substitute; decision will be made by the FdSN graduate program director.

Students can enroll in FDSN 594 and FDSN 597 with a maximum of 6 credit hours total between both courses with an FdSN adviser approval. However, when FDSN 597 is used as a short course, the total credit hours must not exceed 8 between FDSN 594 and FDSN 597 combined. The student must have a minimum grade point average of 3.0/4.0. In addition to the core courses required and electives, further courses may be selected from other departments with the approval of the FdSN adviser, to fit the background and needs of the individual student.

Master of Food Safety and Technology with Specialization in Business

32 credit hours

This program is designed to help food safety and technology degree students extend their food science technical and practical knowledge of the field while introducing them to core topics in modern business practices to prepare them for careers in the industry. To complete the program, students must satisfy the Master of Food Safety and Technology requirements and Stuart School of Business specialization, totaling 32 credit hours. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

N*ote: Stuart School of Business tuition and fees apply to these courses. Applicants to the program are not required to take the GMAT.*

Specialization Core Course Requirement			(3)
BUS 510	Building an Innovative and Sustainable Business		3
Specialization Electives			(6)
Select a minimum of two courses from the following:			6
MBA 501	Accounting for Strategic Decision-Making	3	
MBA 509	Financial Management in a Globalized World	3	
MBA 511	Creating, Communicating, and Delivering Customer Value	3	

MBA 513	Operations and Technology Management	3	
Total Credit Hours			9

Master of Food Safety and Technology with Specialization in Industrial Management

32 credit hours

This program is designed to help food safety and technology degree students extend their food science technical and practical knowledge of the field while introducing them to core topics and providing up-to-date knowledge of the technologies and modern management approaches used in world-class industrial companies. To complete the program, students must satisfy the Master of Food Safety and Technology requirements and Industrial Technology and Management specialization requirements, totaling 32 credit hours.

Specialization Electives			(9)
Select a minimum of three courses from the following:			9
INTM 508	Cost Management	3	
INTM 511	Industrial Leadership	3	
INTM 515	Advanced Project Management	3	
INTM 518	Industrial Risk Management	3	
INTM 520	Applied Strategies for the Competitive Enterprise	3	
Total Credit Hours			9

Master of Science in Food Process Engineering

Curriculum

Candidates are required to take a total of 32 credit hours, 18 of which are the required courses listed below, 6-8 credit hours in research and thesis, 6 credit hours must be taken from Department of Chemical and Biological Engineering courses, and the remaining 1-2 credit hours can be taken from FDSN electives, if needed.

Core Courses			(18)
FDSN 505	Food Microbiology		3
FDSN 506	Food Microbiology Laboratory		3
FDSN 521	Food Process Engineering		3
FDSN 522	Advanced Food Process Engineering		3
FDSN 524	Fundamentals of Food Science		3
FDSN 541	Principles of Food Packaging		3
Thesis Research			(6-8)
FDSN 591	Research and Thesis		6-8
Elective Courses			(6)
Select a minimum of two courses from the following:			6
CHE 426	Statistical Tools for Engineers	3	
CHE 439	Numerical and Data Analysis	3	
CHE 494	Process Design I	3	
CHE 560	Statistical Quality and Process Control	3	
CHE 577	Bioprocess Engineering	3	
ENVE 513	Biotechnological Processes in Environmental Engineering	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
FPE Electives			(1-2)
Select 1-2 credit hours from the following:			1-2
FDSN 501	Nutrition, Metabolism, and Health	3	
FDSN 502	Development, Delivery, and Dissemination	3	
FDSN 504	Food Biotechnology	3	
FDSN 507	Food Analysis	3	
FDSN 508	Food Product Development	3	
FDSN 511	Food Law and Regulations	3	

FDSN 520	Low-Acid Canned Food Regulations and Microbiology [1]	3
FDSN 523	Food Engineering Process Delivery [1]	3
FDSN 526	Engineering Principles of Food [1]	3
FDSN 531	HACCP Planning and Implementation	3
FDSN 593	Seminar on Food Safety and Technology	1
FDSN 594	Special Projects	1-6
FDSN 597	Special Problems	1-6

Minimum degree credits required: 32

[1] Courses are designed specifically for the Certificate in Food Processing Specialist program.

Research for the thesis must be carried out under the direct supervision of a participating faculty member. Based on the requirements of the research project, thesis committee members may be chosen from university faculty members from various departments, FdSN/FDA scientists, and the food industry scientists. The final thesis examination consists of submission of a written thesis, followed by an oral presentation open to all IFSH staff and the university community. A thesis may be completed outside the department only by special arrangement with the department chair. The final examination is normally oral, but may be written at the discretion of the thesis examining committee.

As a part of the thesis, the student is expected to contribute to one or more high quality peer-reviewed journal article(s). The student is also encouraged to present the research at a national professional society meeting.

Students may enroll in a ChBE course that is not listed above, with FdSN adviser approval.

Master of Science in Food Safety and Technology

Curriculum

Candidates are required to take a total of 32 credit hours, 18 of which must be selected from the core food safety and technology courses listed below, 6-8 credit hours must be in research and thesis work and 6-8 credit hours from electives. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Core Course			(18)
FDSN 505	Food Microbiology		3
FDSN 506	Food Microbiology Laboratory		3
FDSN 507	Food Analysis		3
FDSN 521	Food Process Engineering		3
FDSN 524	Fundamentals of Food Science		3
FDSN 541	Principles of Food Packaging		3
Thesis Research			(6-8)
FDSN 591	Research and Thesis		6-8
Electives			(6-8)
Select 6-8 credit hours			6-8
FDSN 501	Nutrition, Metabolism, and Health	3	
FDSN 502	Development, Delivery, and Dissemination	3	
FDSN 504	Food Biotechnology	3	
FDSN 508	Food Product Development	3	
FDSN 511	Food Law and Regulations	3	
FDSN 531	HACCP Planning and Implementation	3	
FDSN 593	Seminar on Food Safety and Technology	1	
FDSN 594	Special Projects	1-6	
FDSN 597	Special Problems	1-6	

Minimum degree credits required: 32

Research for the thesis must be carried out under the direct supervision of a participating faculty member. Based on the requirements of the research project, thesis committee members may be chosen from university faculty members from various departments, FdSN/FDA scientists, and the food industry scientists. The final thesis examination consists of submission of a written thesis followed by an oral presentation open to all FdSN/IFSH staff and the university community. As a part of the thesis, the student is expected to contribute scholarly article(s) to one or more high quality peer-reviewed journals. The student is also encouraged to present the research at a national professional society meeting.

Students may enroll in FDSN 594 and FDSN 597 up to a maximum of 2 credit hours between both courses when enrolled in 6 credit hours of thesis; or 1 credit hour when enrolled in 7 credit hours of thesis. However, if the FDSN 597 is used as a short course, the student can register up to 4 credit hours in FDSN 597 with FdSN adviser approval. Students may not enroll in FDSN 594 or FDSN 597 when using 8 credit hours of thesis unless FDSN 597 is used as a short course.

Students must have a minimum grade point average of 3.0/4.0. In addition to the core courses required and electives, further courses may be selected from other departments with the approval of the FdSN adviser to fit the background and needs of the individual student.

Doctor of Philosophy in Food Science and Nutrition

The Doctor of Philosophy in Food Science and Nutrition is awarded in recognition of mastery in food science and nutrition and upon demonstration of an ability to make substantial creative contributions to knowledge in food safety, food science, and nutrition. The recipients of the doctoral degree will be capable of continuing independent efforts toward advancement of scientific knowledge in the food-related business.

Admission Requirements

An applicant to the doctoral program must hold a master of science degree in microbiology; chemistry; biology; food science; nutrition; chemical, agricultural, food, or environmental engineering; or a related field. The applicant should meet all entrance requirements of the university's Graduate College, plus minimum cumulative undergraduate and graduate GPAs of 3.0 on a 4.0 scale; a GRE score of at least 304 (combined quantitative and verbal); and a TOEFL score of at least 80/213/515 (internet/computer/paper-based) for international applicants. Please note that meeting the minimum GPA and test score requirements does not guarantee admission to the program.

Curriculum

The requirements for the Doctor of Philosophy in Food Science and Nutrition consist of a program of 72 credit hours approved by the faculty adviser, passing the Ph.D. qualifying and comprehensive examinations, and the completion of a research dissertation supervised by a faculty member and approved by a dissertation committee. The required 72 credit hours consist of 29 credit hours of core courses, 17 credit hours of elective courses, 24 credit hours of FDSN 691, and 2 credit hours of FDSN 695. The one credit hour FDSN 695 course is offered during every spring and fall semester. Students who have already completed a master of science degree in food science from Illinois Institution of Technology or other universities should consult with the faculty adviser as to how many credit hours may be transferred from their previous degree.

Core Courses			(29)
FDSN 502/402	Development, Delivery, and Dissemination		3
FDSN 505	Food Microbiology		3
FDSN 506	Food Microbiology Laboratory		3
FDSN 507	Food Analysis		3
FDSN 521	Food Process Engineering		3
FDSN 524	Fundamentals of Food Science		3
FDSN 531	HACCP Planning and Implementation		3
FDSN 610	Advanced Topics in Food Microbiology		2
FDSN 620	Advanced Topics in Food Chemistry		2
FDSN 630	Advanced Topics in Nutrition		2
FDSN 640	Advanced Topics in Food Process Engineering		2
Seminar Requirement			(2)
Students must complete two food science and nutrition seminars (FDSN 695) at one credit hour each			2
Elective Courses			(17)
Select 17 credit hours from the following: [1]			17
BIOL 503	Virology	3	
BIOL 512	Advanced Biochemistry	3	
BIOL 514	Toxicology	3	
BIOL 544	Molecular Biology of Cells	3	
BIOL 562	Current Topics in Functional Genomics	3	
CHE 560	Statistical Quality and Process Control	3	
CHE 577	Bioprocess Engineering	3	

CHEM 500	Advanced Analytical Chemistry	3
FDSN 501	Nutrition, Metabolism, and Health	3
FDSN 504	Food Biotechnology	3
FDSN 508	Food Product Development	3
FDSN 511	Food Law and Regulations	3
FDSN 522	Advanced Food Process Engineering	3
FDSN 523	Food Engineering Process Delivery	3
FDSN 526	Engineering Principles of Food	3
FDSN 541	Principles of Food Packaging	3
FDSN 594	Special Projects	1-6
FDSN 597	Special Problems	1-6
Ph.D. Research		(24)
Students must complete 24 credit hours of FDSN 691		24
Total Credit Hours		72

[1] Other courses may be used to fulfill the elective requirement pending adviser approval.

Ph.D. Written Qualifying Examination

Students must pass a written qualifying examination within three semesters after they are admitted to the Ph.D. program. The exam is diagnostic in nature and the results of the exam will determine the student's potential for success in the FdSN Ph.D. program and recommendations for a future program of study. The examination will cover four core areas in the discipline of food science and nutrition: food microbiology, food chemistry, food engineering, and nutrition.

Comprehensive Examination

The comprehensive examination is oral and will include a written exam based on the student's performance on the qualifying exam. The exam questions will be formulated by the members of the Ph.D. examining committee. The examination will also include an oral presentation and discussion by the student of a journal article previously selected by the examining committee. The exam must be conducted within a year following the completion of the qualifying exam. The student must request the appointment of an examination committee using Form G301. The examination committee may consist of four members and must include at least three full-time faculty members from the Department of Food Science and Nutrition and one full-time faculty member from another department in the university. Other committee members from inside or outside of the university may be chosen. The student should consult with his or her research adviser concerning the makeup of the committee. The Ph.D. examination committee, which may be the same as the Ph.D. thesis committee, should be suggested by the adviser and approved by the chairperson at least six weeks prior to the examination. The major portion of the research should not be started until the comprehensive examination is passed and the dissertation proposal is approved by the committee.

Dissertation and Oral Defense

Each student must present an oral defense of his or her Ph.D. dissertation work. The Ph.D. dissertation committee is appointed in the same way as the comprehensive exam committee. FdSN doctoral research can begin after admission to the Ph.D. program. All research must be conducted under the supervision of a full-time FdSN faculty member. The preliminary dissertation draft must meet the approval of all members of the examination committee. The oral examination is given as an open research seminar followed by a closed oral defense of the dissertation with only the Ph.D. dissertation committee. The final dissertation and oral defense must meet the approval of the examination committee and a majority of favorable votes are required to pass the Ph.D. dissertation defense. The committee has the authority to determine whether or not to grant a reexamination.

Certificate in Food Process Engineering

Curriculum

This program provides an introduction to the field of food engineering, with applications of chemical engineering principles to food manufacturing and food safety. Students must complete four courses (12 credit hours) for the certificate. Students who are admitted to FdSN master's degree programs may apply coursework previously taken in a FdSN certificate program towards the requirements for the master's degree with 3.0/4.0 GPA. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Required Courses			(12)
FDSN 521	Food Process Engineering		3
FDSN 522	Advanced Food Process Engineering		3
Select a minimum of two courses from the following:			6
FDSN 504	Food Biotechnology	3	
FDSN 505	Food Microbiology	3	
FDSN 506	Food Microbiology Laboratory	3	
FDSN 507	Food Analysis	3	
FDSN 508	Food Product Development	3	
FDSN 511	Food Law and Regulations	3	
FDSN 524	Fundamentals of Food Science	3	
FDSN 531	HACCP Planning and Implementation	3	
FDSN 541	Principles of Food Packaging	3	
Total Credit Hours			12

Certificate in Food Processing Specialist

Curriculum

This program provides a broad working knowledge of technical elements of thermal processing systems (with understanding of alternative technologies) to qualify at an intermediate level as a recognized Food Processing Specialist. Students must complete four courses (12 credit hours). Students who are admitted to FdSN FPE master's degree program may apply coursework previously taken in this certificate program towards the requirements for the FPE master's degree with 3.0/4.0 GPA. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Required Courses		(12)
FDSN 520	Low-Acid Canned Food Regulations and Microbiology	3
FDSN 522	Advanced Food Process Engineering	3
FDSN 523	Food Engineering Process Delivery	3
FDSN 526	Engineering Principles of Food	3
Total Credit Hours		12

Certificate in Food Safety and Industrial Management

Curriculum

This program is designed to help students extend their food science technical and practical knowledge of the field while introducing them to core topics and providing up-to-date knowledge of the technologies and modern management approaches used in world-class industrial companies.

Food Safety and Technology Electives			(6)
Select a minimum of two courses from the following:			6
FDSN 505	Food Microbiology	3	
FDSN 511	Food Law and Regulations	3	
FDSN 531	HACCP Planning and Implementation	3	
Industrial Technology and Management Electives			(6)
Select a minimum of two courses from the following:			6
INTM 508	Cost Management	3	
INTM 511	Industrial Leadership	3	
INTM 515	Advanced Project Management	3	
INTM 518	Industrial Risk Management	3	
INTM 520	Applied Strategies for the Competitive Enterprise	3	
Total Credit Hours			12

Certificate in Food Safety and Technology

The certificate program provides students with post baccalaureate knowledge of food safety and technology and its applications in the food industry, and in federal and state public health agencies.

Curriculum

This program requires 12 credit hours for completion. Students who are admitted to FdSN master's degree programs may apply coursework previously taken in a FdSN certificate program towards the requirements for the master's degree with 3.0/4.0 GPA. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Select a minimum of four courses from the following:			12
FDSN 501	Nutrition, Metabolism, and Health	3	
FDSN 504	Food Biotechnology	3	
FDSN 505	Food Microbiology	3	
FDSN 506	Food Microbiology Laboratory	3	
FDSN 507	Food Analysis	3	
FDSN 508	Food Product Development	3	
FDSN 521	Food Process Engineering	3	
FDSN 524	Fundamentals of Food Science	3	
FDSN 531	HACCP Planning and Implementation	3	
FDSN 541	Principles of Food Packaging	3	
Total Credit Hours			12

Industrial Technology and Management

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Director
Mazin Safar

Program Manager
Pamela Houser

Faculty with Research Interests
For more information regarding faculty visit the Department of Industrial Technology and Management website.

The Master of Industrial Technology and Operations (MITO) is designed to enhance the ability of students to pursue their professional goals by providing up-to-date knowledge of the technologies and modern management approaches used in world-class industrial companies. The curriculum prepares students to move into management, supervisory, and staff positions in industry. Considered to be a hybrid degree, the MITO blends practical application of current technologies with the management skills needed to oversee a wide range of industrial operations. Students build a program of study suited to their career interests and experience. The MITO is not a M.B.A. or an engineering degree, therefore it is not recommended for those planning to pursue careers in academia or research.

Admission Requirements

Applicants must hold a four-year bachelor's degree from an accredited institution. Students with a GPA of 3.0/4.0 can be admitted unconditionally. Students with a GPA of 2.5/4.0 can be admitted contingent upon their earning a GPA of 3.3 or better in the first three courses taken at the university. The GRE is not required for applicants who have completed a degree at a U.S. institution.

Applicants who have completed an undergraduate degree outside the U.S. must complete the GRE and submit scores with the admission application. Minimum required GRE scores are 2.5 for analytical writing and a combined score of 292 for the verbal and quantitative portions of the exam taken August 2011 and after. Applicants from countries where English is not the primary language also must complete the TOEFL with a minimum score of 70 on the internet-based test (equivalent to 523 PBT) with no individual section scored below 15. IELTS scores are also accepted, with a minimum score of 5.5. Students with a TOEFL score between 70 and 89 or an IELTS score between 5.5 and 6.0 will be required to complete an English assessment test upon arrival at the university to identify need and placement in a remedial English course during the first term of study.

All applicants must submit a completed application form, the application fee, official transcripts (or certified copies) for all academic work at the college level, and a professional statement. International students must also submit financial support documentation verifying sufficient funds to cover degree studies and living expenses.

Prospective students who have previously obtained a M.S. or even a Ph.D. in highly technical subjects may be well served to pursue the MITO degree. These individuals are often technical experts who, once employed in industry, have found that they lack an understanding of industrial operations, applied technologies, and management skills. As a hybrid program covering both technology and management, the MITO curriculum enables such specialists to move into operations or management.

Degree Offered

- Master of Industrial Technology and Operations (p. 380)

Course Descriptions

INTM 502
Fundamentals of Industrial Engineering
Industrial engineering concepts are introduced and the student prepared to perform basic engineering tasks, including design of workstations, cells and lines. Coverage includes time and motion studies, work measurement, ergonomics, route sheets, plant layout, site selection, equipment selection, MRP, JIT, etc. Scheduling techniques will be covered along with material control techniques. Management Information Systems (MIS) are introduced and options covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 507
Construction Technology
Introduces the full range of technologies involved in construction of both new and modified facilities, including steel, concrete and timber construction as well as supporting specialties such as HVAC, electrical, plumbing, etc. The interactions between the various construction trades will be covered along with the role of the architects and engineers.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 508
Cost Management
Accounting basics are introduced with primary emphasis on the costing and estimating procedures as used in industry. The objective of this course is to provide a good understanding of financial activities and hands-on experience in working with a variety of costing and accounting systems.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 509
Inventory Control
Fundamentals of inventory control including inventory classifications, i.e. raw materials, work-in-process (WIP) and finished goods. Topics include inventory record keeping, inventory turnover, the 80/20 (or ABC) approach, external and internal lead times, excess/obsolete inventory, and inventory controls. Material Resource Planning (MRP) are included.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 511
Industrial Leadership
Supervision and management practices are key to all components and sectors of industry. People are the key resources and their effective use is critical to a successful operation. As companies move to become high performance organizations, traditional management tools and techniques have to be reviewed and reconsidered. Skills covered include motivation, developing consensus, conflict avoidance and negotiations. Group dynamics along with handling of individual workers is critical.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 514
Topics in Industry
This course provides overview of multiple industrial sectors and the influences that are forcing change. All aspects of industry are considered: history of industry, inventory, supply chain, e-commerce, management, manufacturing, industrial facilities, resource management, electronics and chemical industries, alternate energies, marketing, entrepreneurship, computers as tools, and other specialty areas.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 515
Advanced Project Management
This course covers project management in the PMP framework and provides a structured approach to managing projects using Microsoft Project and Excel. Coverage includes creation of key project management charts (Gantt, Pert, CPM, timelines and resource utilization), basic statistics used in estimating task times, critical path generation in Excel and Project, project cost justification in Excel, SPC and acceptance sampling for machine, project analysis via simulation, and management of personnel, teams subcontractors and vendors. Case studies are utilized to demonstrate core concepts and dynamic scheduling.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 516
Integrated Facilities Management
Integrated Facilities Management involves understanding processes and tools needed to successfully manage building systems, functions, and personnel in any type of building, complex of buildings, or physical environment. Course covers topics in facilities management ranging from routine maintenance to complex systems interactions and financial decisions. Students learn to assess issues of safety, human comfort, sustainable use of resources, building and infrastructure life cycles, and company objectives and develop solutions based on studying real problems in facilities management organizations.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 518
Industrial Risk Management
Each year industrial companies are affected by critical incidents which cause disruptions in operations and significant monetary losses due to repairs and/or lost revenue. Whether it is a small fire, an extended electrical outage or an incident of a more serious magnitude, all company stakeholders-from the board of directors to the employees to the customers -are impacted. The key to understanding the complexities of industrial resiliency lies in focusing on the issues of preparedness: prevention, mitigation and control. This course is designed to prepare the student for managing a critical incident, including understanding risk and business impact, emergency preparedness, contingency planning and damage control.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 520
Applied Strategies for the Competitive Enterprise
Course covers the application of proven management principles and operational practices. Learn how high performance companies create a competitive advantage despite economic challenges and a transitional customer base. Factors covered include strategy deployment, financial analysis, new product development, quality, customer service, and attaining market leadership. Case studies illustrate variable impacts on business situations.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 522
Computers in Industry
Computers are ubiquitous in all industrial sectors. Management Information Systems (MIS) are available for even the most complex of industrial operations. The integration of MIS with operational specialties (such as order entry, production scheduling, quality control, shipping and invoicing) is discussed. A variety of Microsoft Excel tools are introduced and utilized to set up approaches for handling a variety of industrial situations.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 530
Transportation
This course covers transportation practices and strategies for the 21st century. The role and importance of transportation in the economy and its relationship to the supply chain will be covered in detail. Transportation modes -- trucks, rail, air, and water -- will be examined for both domestic and global transportation. Costing and pricing strategies and issues will be discussed as well as security issues in domestic and international transportation.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 531
Manufacturing Processes for Metals and Mechanical Systems
A broad range of manufacturing processes are studied including casting, forging, rolling, sheet metal processing, machining, joining, and non-traditional methods such as powder, EDM, and additive processes. Particular attention on interrelationships between manufacturing processes and properties developed in the work piece, both intended and unintended. Economic considerations and tradeoffs, as well as computer-integrated manufacturing topics, are also explored.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 532
Manufacturing Processes for Electronics and Electrical Systems
The materials used in Electronic and Electrical (E&E) manufacturing will be reviewed including materials and components that are used to produce chips, PCBs, and wiring systems. Focus will be on the processes for producing the range of parts and products included in this broad sector. Automation for producing parts and assemblies will be covered. Techniques covered will include surface mounted technology (SMT), wave soldering, automation insertion, automated inspection, etc. The industrial structure that makes up this sector of manufacturing will be covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 533
Chemical Manufacturing Processes in Industry
This course provides an overview of current and emerging chemical processes employed in the energy, food, drug, and plastics sectors. Current and future impacts of various manufacturing processes on society, environment, and sustainability are covered as are issues related to OSHA, EPA, FDA, USDA, and other regulatory systems. The various implications of recovery and reuse are explored as well as new non-polluting, zero-emissions processes and technologies. Students will gain an appreciable understanding of "how it's made"and the range of chemical processes and related technical challenges involved in manufacturing. A background in chemistry is not required.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 540
Supply Chain Management
This course covers the full range of activities involved in the supply chain. This includes management tools for optimizing of supply chains, relationships with other parts of the organization, in-house versus third party approaches, and suitable performance measurements. Topics covered include Warehouse Management Systems (WMS), Transportation Management Systems (TMS), Advanced Planning and Scheduling Systems (APS) as well as cost benefit analysis to determine the most appropriate approach.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 542
Warehousing and Distribution
This course covers warehouse layout and usage based on product requirement such as refrigeration, hazardous material, staging area, and value added activities. Processes covered include receiving, put-away, replenishment, picking, and packing. The requirement for multiple trailer/rail car loading and unloading is considered as well as equipment needed for loading, unloading and storage. Computer systems for managing the operations are reviewed. Emphasis is on material handling from warehouse arrival through warehouse departure.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 543
Purchasing
Purchasing responsibilities, processes, and procedures are included. Topics covered include: supplier selection and administration, qualification of new suppliers, preparing purchase orders, negotiating price and delivery, strategic customer/vendor relationships, and resolution of problems. All aspects of Supplier Relation Management (SRM) are covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 544
Export/Import
Internationalization of industry requires special expertise and knowledge, which must be taken into consideration throughout all interactions with overseas companies either as customers or suppliers. Topics covered include custom clearance, bonded shipping, international shipping options, import financing and letters of credit, customer regulations, insurance, import duties and trade restrictions, exchange rates, and dealing with different cultures.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 545
Strategic International Business
Organizational involvement in international business activities -- whether sourcing material and designs, expanding product sales and reach, or creating economies of scale and scope -- requires an understanding of various factors in international finance, marketing, and strategy. This course brings together these disciplines to explore financial factors that may add or transform risks, the necessary adjustments in the creation of global marketing strategy, and the strategies for creating and preserving a competitive advantage in the international arena.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 546
Manufacturing and Logistics Information Systems
This course provides an overview of manufacturing and supply chain information systems, tools, and techniques utilized for effective decision making. Current state-of-the-art and commercially available industrial software packages, such as MRP, WMS, TMS, APS, etc., will be used and their impact on management decision making analyzed.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 547
Supply Chain Strategies
The range of supply chain strategies to be considered when assessing a firm's internal and external supply chain network. Strategies involved in the end-to-end supply chain including product life cycle management (PLM), inventory optimization, network design optimization, management tools for optimizing supply chains, relationships with other parts of the organization, in-house versus third-party approaches, and suitable performance measurements.
Prerequisite(s): [(INTM 441) OR (INTM 540 with min. grade of C)]
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 559
Issues in Industrial Sustainability
Examines the concept of sustainability and its application in the industrial environment. Identifies underlying stresses on natural and human environments and the resultant problems for business and society including legal, ethical, and political issues related to sustainability. Global warming, peak oil, and commodity pricing are considered as indicators of the need for improvements in sustainability. Industrial ecology will be discussed as well as strategies for developing sustainable practices in manufacturing, power generation, construction, architecture, logistics, and environmental quality. Coverage includes case studies on businesses that have developed successful sustainability programs.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 560
Sustainability of Critical Materials
This course explores the limitations in supply and the need for sustainable use of carbon and non-carbon-based materials such as oil, minerals, food, water, and other natural resources used by industry. Limitations in the global availability of such resources pose challenges to industry which will require careful consideration and planning to ensure continued prosperity for current and future generations. Course will cover strategies and options to mitigate anticipated shortages and optimize the use of non-renewable natural resources, review of fuel and raw material pricing, and cost/benefit analysis of sustainable development proposals. Technical analyses will be presented during class discussions, but a technical background is not required.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 561
Energy Options in Industry
Carbon-based fuels are a limited resource and within decades will be in very short supply. Associated energy costs will increase and industry will be required to incorporate alternate fuels and/or power sources, such as uranium (for nuclear power), hydroelectric, geothermal, wind, wave, solar, etc. This course presents such energy options and explores the anticipated impact on industry.
Lecture: 3 **Lab:** 0 **Credits:** 3

INTM 562
Special Topics in Sustainability
This course allows the student to research and report on an industrial sustainability issue of interest and relevance to their career objectives. Topics may touch on industrial ecology, ethics, regulations, environment, resource use, alternative manufacturing methods, facilities, logistics, etc. This is the fourth course in a specialization in industrial sustainability.
Lecture: 0 **Lab:** 0 **Credits:** 3

INTM 594
Special Projects
Special project.
Credit: Variable

INTM 597
Special Projects
Independent study and project. Permission of instructor required.
Credit: Variable

Master of Industrial Technology and Operations

Each student's plan of study is customized to best serve individual career objectives. Of the 30 credit hours required for the MITO degree, the student must complete at least 18 credit hours of INTM graduate courses. Up to 12 credit hours of senior (400-level) courses may be completed as part of the degree. A maximum of 6 credit hours may be applied from special project courses (INTM 597) or an Interprofessional Project (IPRO 497). A total of 9 credit hours taken at a different university (passed with the grade of "B" or better) may be transferred to the university and applied towards the MITO degree if those credits have not been applied toward any earned degree (subject to administrative approval). No thesis or comprehensive examination is required as part of this degree.

The flexibility of course options within the MITO program allows students to complete an industrial specialization, or simply take the ten courses of greatest interest. A specialization requires the completion of 12 credit hours (four courses) in any one of four concentrations within the INTM curriculum: Industrial Facilities (IF), Industrial Sustainability (ST), Manufacturing Technology (MT), or Supply Chain Management (SCM). Alternatively, students may complete up to four courses in another university department with appropriate qualifications and approvals. For example, students have taken courses from Stuart School of Business, Armour College of Engineering, and the food science and nutrition program.

INTM courses are presented live at the university's Mies Campus in Chicago, and via interactive video at the Rice Campus in Wheaton, Illinois. In addition, the MITO program can be completed entirely online. Using a delayed Internet format (lecture videos are posted within 24 hours after the live session), students can log on and view lectures at the time and location of their choice.

Curriculum

Elective Courses			(18-30)
Select a minimum of 18-30 credit hours from the following: [1]			18-30
INTM 404	Marketing, Sales, and Product Introduction	3	
INTM 406	Quality Control	3	
INTM 410	Operations Management	3	
INTM 413	Contract Administration for Construction Projects	3	
INTM 417	Construction Estimating	3	
INTM 425	Human Resource Management	3	
INTM 427	E-Commerce	3	
INTM 432	Sales and Operations Planning	3	
INTM 477	Entrepreneurship in Industry	3	
INTM 502	Fundamentals of Industrial Engineering	3	
INTM 507	Construction Technology	3	
INTM 508	Cost Management	3	
INTM 509	Inventory Control	3	
INTM 511	Industrial Leadership	3	
INTM 515	Advanced Project Management	3	
INTM 516	Integrated Facilities Management	3	
INTM 518	Industrial Risk Management	3	
INTM 520	Applied Strategies for the Competitive Enterprise	3	
INTM 522	Computers in Industry	3	
INTM 530	Transportation	3	
INTM 531	Manufacturing Processes for Metals and Mechanical Systems	3	
INTM 532	Manufacturing Processes for Electronics and Electrical Systems	3	
INTM 533	Chemical Manufacturing Processes in Industry	3	
INTM 540	Supply Chain Management	3	
INTM 542	Warehousing and Distribution	3	
INTM 543	Purchasing	3	
INTM 544	Export/Import	3	
INTM 545	Strategic International Business	3	
INTM 546	Manufacturing and Logistics Information Systems	3	
INTM 547	Supply Chain Strategies	3	
INTM 559	Issues in Industrial Sustainability	3	
INTM 560	Sustainability of Critical Materials	3	

INTM 561	Energy Options in Industry	3
INTM 597	Special Projects [2]	0-6
Optional Specialization Courses		(0-12)
Select 12 credit hours from approved specialization courses [3]		0-12

Minimum degree credits required: 30

1 Up to 12 elective credit hours of 400-level INTM courses may be completed. Up to 12 elective credit hours of 400- or 500-level courses from a different academic discipline may be completed, with adviser and instructor approval.

2 Students may complete an optional special project for up to 6 credit hours.

3 Students may select courses in order to fulfill a desired specialization. See Specializations tab on this page for more details.

Specialization Courses

Four industrial specializations are available. To earn a specialization, the student must complete four courses within an identified focus area.

Industrial Facilities

Select a minimum of four courses from the following:		12
INTM 413	Contract Administration for Construction Projects	3
INTM 417	Construction Estimating	3
INTM 507	Construction Technology	3
INTM 515	Advanced Project Management	3
INTM 516	Integrated Facilities Management	3
Total Credit Hours		12

Industrial Sustainability

Select a minimum of four courses from the following:		12
INTM 559	Issues in Industrial Sustainability	3
INTM 560	Sustainability of Critical Materials	3
INTM 561	Energy Options in Industry	3
INTM 562	Special Topics in Sustainability	3
Total Credit Hours		12

Manufacturing Technology

Select a minimum of four courses from the following:		12
INTM 406	Quality Control	3
INTM 531	Manufacturing Processes for Metals and Mechanical Systems	3
INTM 532	Manufacturing Processes for Electronics and Electrical Systems	3
INTM 533	Chemical Manufacturing Processes in Industry	3
INTM 546	Manufacturing and Logistics Information Systems	3
Total Credit Hours		12

Supply Chain Management

Select a minimum of four courses from the following:			12
INTM 432	Sales and Operations Planning	3	
INTM 509	Inventory Control	3	
INTM 530	Transportation	3	
INTM 540	Supply Chain Management	3	
INTM 542	Warehousing and Distribution	3	
INTM 543	Purchasing	3	
INTM 544	Export/Import	3	
INTM 546	Manufacturing and Logistics Information Systems	3	
INTM 547	Supply Chain Strategies	3	
Total Credit Hours			12

Information Technology and Management

Perlstein Hall
10 W. 33rd Street, Room 223
Chicago, IL 60616
appliedtech.iit.edu/information-technology-and-management

Daniel F. and Ada L. Rice Campus
201 E. Loop Road
Wheaton, IL 60189

Dean and Chair
C. Robert Carlson

Faculty with Research Interests
For more information regarding faculty visit the Department of Information Technology and Management website.

The mission of the Department of Information Technology and Management is to educate and inform students to prepare them to assume technical and managerial leadership in the information technology and cyber security fields. The information technology and management degrees apply a hands-on, reality-based approach to education that allows students to apply what they learn in class to solve real-life problems. Additional courses may be taken from the Chicago-Kent College of Law curriculum to give cyber security and forensics practitioners a thorough grounding in legal issues and compliance. The program provides an innovative experience where students work on cutting-edge, industry-sponsored projects. This teaching philosophy prepares students to become innovators, entrepreneurs and leaders of the future. For some areas of study, it is possible to complete the entire Master of Information Technology and Management degree online.

Laboratories and Research Centers

The School of Applied Technology operates and administers over 400 computers and servers at the Mies and Rice campuses to support teaching, learning and research. Ten laboratories include a networking/network security and computer forensics facility, and a dedicated Real-Time Communications (RTC) facility which includes an entire CISCO VoIP LAN as well as video and mesh wireless capabilities. The security/forensics and RTC laboratories as well as the general-use laboratories provide additional facilities for student projects and applied research, some of which is undertaken in conjunction with industry partners. Some laboratories are available for student use outside of class hours, and one or more laboratories are available for student use weekdays between 10 a.m. and 10 p.m. at the Rice Campus. A wireless network at the Rice Campus provides complete coverage of the campus and operates at all times that the campus is open. Students make extensive use of the network infrastructure provided to support personal notebook computers.

The Center for Cyber Security and Forensics Education

The Center for Cyber Security and Forensics Education (C^2SAFE) is a multi-disciplinary center within the School of Applied Technology. The objectives of the Center for Cyber Security and Forensics Education are to:

- Develop, promote and support education and research in cyber security technologies and management, information assurance, and digital forensics across all academic disciplines at Illinois Institute of Technology.
- Engage with business and industry, government, professional associations, and community colleges to enhance knowledge, awareness, and education in cyber security and digital forensics and improve practices in information assurance.
- Coordinate the designation of Illinois Institute of Technology as a National Center of Academic Excellence in Cyber Defense Education by the National Security Agency and the Department of Homeland Security.
- Maintain resources for education and research in cyber security and digital forensics, publish student and faculty research in the field, and sponsor, organize, and conduct conferences and other events to promote and advance cyber security and forensics education.
- Support university academic departments in the delivery of the highest caliber of cyber security and digital forensics education.

The center plans, organizes and conducts the annual ForenSecure conference in the spring of each year, as well as additional activities and student competitions that advance the mission of the center.

The center actively cooperates and coordinates activities with agencies of the federal government and with professional organizations and programs such as the Information Systems Security Association (ISSA), the Information Systems Audit and Control Association (ISACA), the Association of Information Technology Professionals (AITP), the Association for Computing Machinery (ACM), the Institute of Electrical and Electronic Engineers (IEEE), UNIFORUM, CompTIA, Infragard, and others. The center makes every effort to engage in joint activities with these organizations and to encourage them to engage with the center whenever possible.

Resources for education and research as well as published student and faculty research in the form of technical reports and white papers are available on the center's website at ccsafe.iit.edu/.

Placement Examinations

Students entering the Master of Information Technology and Management degree program may be required to take placement examinations based on an evaluation of their background and their undergraduate degree program.

Students may be required to demonstrate proficiency in the use of a contemporary object oriented programming language through completion of a programming proficiency examination. Students will be requested to complete a representative set of basic programming tasks and will have a choice of contemporary programming languages in which to complete the tasks; Visual Basic is not an acceptable language for this purpose. References may be consulted, but the test is timed so ability to code is necessary. Students who cannot satisfactorily complete the exam may be required to attend a refresher workshop or short course in their selected programming language, or may be required to complete an ITM programming course; appropriate action will be based on their score on the exam.

Students who are not required to complete the Test of English as a Foreign Language (TOEFL) but have low scores on the GRE verbal may be required to complete an English evaluation. If students cannot pass the examination or evaluation they will be required to enroll in an appropriate PESL course and demonstrate proficiency at course completion.

Accelerated Courses

The program may offer accelerated courses for credit in several areas of information technology and management. (Students should see the definition of accelerated courses (p. 486).)

Accelerated courses provide an opportunity for degree-seeking students at the university to complete graduate degree requirements in a shorter time period. If taken by non-degree seeking students, all courses may be later applied toward the Master of Information Technology and Management degree for those who apply and are accepted to the degree program.

Admission Requirements

Applicants for admission must have earned a four-year bachelor's degree from an accredited institution with a minimum cumulative undergraduate GPA of 3.0/4.0. International applicants are required to submit a GRE score with a minimum score of 300 (combined quantitative and verbal), 151 quantitative, and 3.0 analytical writing and may be required to submit a TOEFL score (see Graduate Admission (p. 12)). Admission as a non-degree student follows the university policy set forth in this bulletin.

Students whose undergraduate degree is not in a computer-related area or who do not have significant experience or certifications in the information technology field will be required to demonstrate proficiency in undergraduate courses that are prerequisites for the graduate program. Proficiency may be demonstrated by taking and passing a written exam or taking and passing, with a grade of "B" or better, the prerequisite undergraduate courses at Illinois Institute of Technology. Proficiency may also be demonstrated by presentation of documentation of equivalent training or certification; in this case waivers of the prerequisites may only be granted by the graduate adviser or the ITM associate director.

Current prerequisites for the Master of Information Technology and Management include computer hardware and operating system literacy (ITM 301 or equivalent coursework, certification, or experience) and an ability to program at a basic level using a contemporary programming language (ITM 311 or ITM 312 or equivalent coursework, certification, or experience); basic knowledge of HTML, CSS, and JavaScript (ITMD 361); and the ability to create and administer databases using a modern database management system (ITMD 421). Students enrolled in undergraduate post-baccalaureate studies (see Graduate Admission (p. 12)) may take these courses as part of that program.

Current prerequisites for the Master of Cyber Forensics and Security include computer hardware and operating system literacy (ITM 301 or equivalent coursework, certification, or experience); an ability to program at a competent level using a contemporary programming language (ITMD 411 or ITMD 510); basic knowledge of networking concepts, protocols, methods, and the Internet (ITMO 440 or ITMO 540); and the ability to create and administer databases using a modern database management system (ITMD 421).

Degrees Offered

- Master of Cyber Forensics and Security (p. 395)
- Master of Information Technology and Management (p. 396)

Certificate Programs

Course Descriptions

ITMD 510
Object-Oriented Application Development
This course covers a broad spectrum of object-oriented programming concepts and application programming interfaces. The student considers the details of object-oriented development in topics of multi-threading, data structure collections, stream I/O and clientinterfaces. Software engineering topics of packaging and deployment are covered as well. Strong emphasis is placed on the creation of applications providing solutions for defined business problems. Hands-on exercises reinforce concepts taught throughout the course.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 511
Application Development Methodologies
Students learn concepts in a systematic approach to the analysis, design, implementation and maintenance of software. Includes studies of the various models of the software life-cycle, software development project management, system requirements analysis, and methodologies for practical application of these models to software development, including the use of CASE (Computer Aided Software Engineering) tools. Students apply these principles in projects to improve the quality of their development process and final products.
Prerequisite(s): [(ITMD 510)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 512
Structured and Systems Programming
Structured programming with advanced concepts including strings, arrays, pointers, data structures, file manipulation, and dynamic memory management. Students create complex applications that work with user input, manipulate user supplied text or text obtained from a file, apply standard library routines for working with literal text, use pointers to store complex structures within arrays, and read and write data from files, the console, and the terminal. The object-oriented programming (OOP) paradigm is covered in depth including the philosophy of OOP, classes and objects, inheritance, template classes, and making use of class libraries. Strong emphasis is placed on the creation of applications providing solutions for defined business problems or specific operating system issues.
Prerequisite(s): [(ITM 312)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 513
Open Source Programming
Contemporary open-source programming languages and frameworks are presented. The student considers design and development topics in system, graphical user interface, network and web programming. Dynamic scripting languages are covered using object-oriented, concurrent and functional programming paradigms. Concepts gained throughout the course are reinforced with numerous exercises which will culminate in an open-source programming project.
Prerequisite(s): [(ITMD 510)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 515
Advanced Software Programming
This course considers Web container application development for enterprise systems. The primary focus is on database connectivity (JDBC) integration with Web application programming using an enterprise-level application framework. A Web application term project considers the design and implementation of a database instance that serves as the information tier in a contemporary 3-tier enterprise solution.
Prerequisite(s): [(ITMD 510)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 519
Topics in Software Development
This course will cover a particular topic in software development varying from semester to semester in which there is particular student or staff interest. The course may be taken more than once but only 9 hours of ITMD 419/519 credit may be applied to a degree.
Credit: Variable

ITMD 521
Client/Server Technologies and Applications
This course covers both concepts and practical applications of distributed data paradigms. This provides a comparison between SQL and MapReduce. The course focuses on how to treat and prepare unstructured data to be used in the MapReduce framework in a parallel fashion. Students will be tasked with learning and demonstrating the MapReduce framework through implementing the Hadoop framework and associated Java technology.
Prerequisite(s): [(ITMD 510)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 523
Advanced Topics in Data Management
Advanced topics in database management and programming including client server application development are introduced. Students will learn the use of Structured Query Language in a variety of application and operating system environments. Expands knowledge of data modeling concepts and introduces object-oriented data modeling techniques with specific attention to the use of database management systems in response to defined business problems.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 525
Topics in Data Science and Management
This course will cover a particular topic in databases, data science, data management, or data analytics, varying from semester to semester, in which there is particular student or staff interest.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 526
Data Warehousing
This class will introduce the student to concepts needed for successfully designing, building and implementing a data warehouse. The class will provide the technological and managerial knowledge base for data modeling approaches such as the star schema and database de-normalization issues. Topics such as loading the warehouse, performance considerations, and other concepts unique to the data warehouse environment will be discussed demonstrated in detail.
Prerequisite(s): [(ITMD 523)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 527
Data Analytics
This is a hands-on course that focuses on the creation, maintenance, and analysis of large informatics databases. Concepts such as data modeling, probability, linear regression, and statistical data analysis are covered in depth. In addition, this course will use large simulated equities, healthcare, insurance, and banking database systems. The student is expected to have a working understanding of relational database concepts as well as SQL.
Prerequisite(s): [(ITMD 523)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 529
Advanced Data Analytics
Informatics is the application of information technology to solve problems in other fields. Informaticists use technology and information to build intelligent systems used to bridge the gaps between information, technology, and the people who use it. The study of informatics is about blending applied mathematics with technology while understanding the broader consequences of computing on society and the problem being solved. It is important for any student to develop a broad perspective of technology and the people it serves. This course builds upon the student's knowledge of mathematical concepts of predictive modeling of samples and populations with an emphasis on applying technology to solve real world problems.
Prerequisite(s): [(ITMD 527)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 532
UML-Based Software Development
Study of software development using the Unified Modeling Language (UML). Covers architecture-driven and component based techniques for modeling object-oriented applications. Particular emphasis is placed on the hands on application of tools and components used for object oriented systems modeling.
Prerequisite(s): [(ITMD 510) OR (ITMD 512) OR (ITMD 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 534
Human and Computer Interaction
Introduction to human-computer interaction, a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use. Emphasis is given to the structure of communication between people and computers, capabilities of people to use computers, concerns that arise in designing and building interfaces, design trade-offs, and the process of specification, design, and implementation of user interfaces. Particular emphasis is placed on practical design and usability of computer system user interfaces.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 535
Human-Computer Interaction Design
Advanced study in human-computer interaction with a particular focus on the design of application and web interfaces.
Prerequisite(s): [(ITMD 534)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 536
Software Testing and Maintenance
This course covers the basic concepts of software testing and maintenance. The Testing Maturity Model provides a framework for developing a more mature test process. Testing techniques, test metrics and test plan management concepts are described within this framework.
Prerequisite(s): [(ITMD 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 545
Web Real-Time Communications
This course covers a set of protocols, architectures, and APIs designed to enable browser-to-browser real-time communication of voice, video, and data. Students will learn to apply basic technologies including WebSockets, HTTP, HTML5, Web Sockets, NAT, STUN, TURN, and ICE to ensure two-way real-time communication is established using the WebRTC API's and architectures. Students will use JavaScript and development environments to create basic data and media applications based on the WebRTC technologies and will record the impact of their applications on the performance and behavior of the networks that carry them.
Prerequisite(s): [(ITMD 510, ITMO 540, and ITMO 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 553
Enterprise Intelligent Device Applications
Intelligent device application development is covered with proprietary enterprise and open-source technologies on media device, mobile, and robotic platforms. Utilizing contemporary toolkits, the student considers design and development on simulated and real "smart" devices including smart phones, tablets, sensors, actuators, drones, and robots. Numerous exercises reinforce concepts gained throughout the course. A term project will integrate course topics into a comprehensive intelligent device application.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 554
Mass-Market Intelligent Device Applications
Intelligent device application development is covered with leading mass-market and open-source technologies on media device, mobile, and robotic platforms. Utilizing contemporary toolkits, the student considers design and development on simulated and real "smart" devices including smart phones, tablets, sensors, actuators, drones, and robots. Numerous exercises reinforce concepts gained throughout the course. A term project will integrate course topics into a comprehensive intelligent device application.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 555
Open-Source Intelligent Device Applications
Intelligent device application development is covered with various technologies on mobile and robotic platforms. Utilizing contemporary toolkits, the student considers design and development on emulated and real "smart" devices including smart phones, personal digital assistants, sensors, actuators, and robots. Numerous exercises reinforce concepts gained throughout the course. A term project will integrate course topics into a comprehensive intelligent device application.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 556
Intelligent Device Projects
Students create projects that exercise and expand their understanding of intelligent device application development. Instructional materials and lectures are provided as needed to support projects. Scope and deliverables will be determined through joint decision of the instructor and students. Students will describe requirements, create test plans as needed, demonstrate the application when applicable, create a written description of the work, and may deliver a formal presentation to an audience appropriate to the scope and scale of the work completed. This course may be taken more than once but only 6 hours of ITMD 556 credit may be applied to a degree.
Prerequisite(s): [(ITMD 553) OR (ITMD 554) OR (ITMD 555)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 562
Web Site Application Development
Programming the Common Gateway Interface (CGI) for Web pages is introduced with emphasis on creation of interfaces to handle HTML form data. CGI programming is taught in multiple languages. Security of Web sites is covered with an emphasis on controlled access sites. Setup, administration and customization of content management systems including blog and portal sites is introduced. Students design and create a Web site including basic CGI programs with Web interfaces and process data flows from online forms with basic database structures.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 563
Intermediate Web Application Development
In-depth examination of the concepts involved in the development of Internet applications. Students will learn the differences and similarities between Internet applications and traditional client/server applications. A discussion of the technologies involved in creating these Internet applications is included, and students will learn to use these technologies to create robust server-side applications.
Prerequisite(s): [(ITMD 510)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 564
Advanced Web Application Development
Strategies for management of electronic commerce allow students to learn to re-engineering established business processes to increase enterprise competitive advantage, provide better customer service, reduce operating costs, and achieve a better return on investment. Students will learn to evaluate, use, and deploy state-of-the-art tools and techniques needed to develop a reliable e-commerce offering on the Web. The course will cover state-of-the-art programming and development tools. This class will provide students with hands-on exposure needed to design and build a fully functional e-commerce Web site.
Prerequisite(s): [(ITMD 563)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 565
Rich Internet Applications
Students learn to create interactive rich Internet applications using Web development frameworks, applications, and techniques that primarily operate on the client-side. These applications often exhibit the same characteristics as desktop applications and are typically delivered through a standards-based Web browser, via a browser plug-in, or independently via sandboxes or virtual machines. Current software frameworks used to download, update, verify and execute these applications are addressed as well as writing applications for deployment in these frameworks.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 566
Service-Oriented Architectures
This course covers IT enterprise systems employing web services technologies in SOA and ESB architectural patterns. The student considers SOA which defines and provisions IT infrastructure and allows for a loosely-coupled data exchange over disparate applications participating in business processes. The simplification of integration and flexible reuse of business components within SOA is greatly furthered by ESB. Lab exercises using contemporary toolkits are utilized to reinforce platform-agnostic course topics.
Prerequisite(s): [(ITMD 510)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMD 567
Web Systems Integration
In this project-based course, student teams will build an enterprise-grade website and web infrastructure integrating server-side applications, databases, and client-side rich internet applications as a solution to a defined business problem.
Prerequisite(s): [(ITMD 562 and ITMD 565)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMD 569
Topics in Application Development
This course will cover a particular topic in application development, varying from semester to semester, in which there is a particular student or staff interest. This course may be taken more than once but only 9 hours of ITMD 569 credit may be applied to a degree.
Credit: Variable

ITMM 537
Service Level Agreements
Management of service level agreements (SLAs) at an enterprise level is presented from both a client and service provider perspective. Fundamental structure and issues of contract law are introduced and various models for management of service level agreements are presented. The role of SLAs in enterprise architecture and planning is addressed, and service level definitions, quality of service, and performance metrics are examined.
Prerequisite(s): [(ITMM 570)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 570
Fundamentals of Management for Technology Professionals
This course explores fundamentals of management for professionals in high-technology fields. It addresses the challenges of the following: managing technical professionals and technology assets; human resource management; budgeting and managerial accounting; management of services, infrastructure, outsourcing, and vendor relationships; technology governance and strategy; and resource planning.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 571
Project Manangement for Information Technology Management
Basic principles of project management are taught. Includes software development concepts of requirements analysis, object modeling and design and software testing. Management of application development and major Web development projects will also be addressed.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 572
Process Engineering for Information Technology Managers
This course will provide students with the knowledge and skills to define, model, measure and improve business processes. The course will focus on re-engineering processes through the application of technology to achieve significant and measurable improvement. The course will explore the latest industry standards and students will use state-of-the-art software tools for hands-on experiential learning.
Prerequisite(s): [(ITMM 570)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 573
Building and Leading Effective Teams
This course will prepare students to be effective IT managers. Students will be introduced to the general challenges of management as well as the challenges unique to leading teams of technology professionals. The course will explore the skills necessary to excel as a leader including dealing with conflict, developing leadership skills, recruiting and developing employees, and leading remote and virtual teams. Students will explore case studies and execute team exercises to enrich their learning experience.
Prerequisite(s): [(ITMM 570)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 574
Information Technology Management Frameworks
This course will examine the application of industry standard frameworks to the management of information technology infrastructure, development and operations. Frameworks including the Information Technology Infrastructure Library (ITIL), Control Objectives for Information and related Technology (COBIT), and others will be covered. Students will learn to use these frameworks to tailor a set of concepts and policies to necessary manage IT in a specific enterprise.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 575
Networking and Telecommunications Management
This course address the design, implementation, and management of computer networks and enterprise telecommunications systems. Design issues in wide area networks and telecommunications with emphasis on Internet connectivity are also addressed. Tools for supporting the distribution and sharing of system resources and information are discussed, along with tools to support network design and management.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 576
Data Center Management
This course is an in-depth examination of best practices in the management of enterprise data centers. Topics include data center consolidation; data center maintenance; server and network management methods and tools; budget and finance; service-level agreements; managing data center personnel and staff; and disaster recovery.
Prerequisite(s): [(ITMT 535)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 577
Case Studies in Management of Information Technology
This course examines approaches and models for the management of information technology at an enterprise level through the use of case studies in the field.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 581
Information Technology Entrepreneurship
This course prepares students to become leaders in information technology and to build ITM companies. Students design and develop a prototype ITM product and prepare a business plan and venture proposal presentation.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 582
Business Innovation
This course is designed to teach innovative thinking through theory, methods, and practice of innovation. The course incorporates Einstein's thinking, and Edison's method to establish the innovation process that can be applied in current business environment. Current economic conditions and global sourcing requires that innovation becomes a leading tool for developing a competitive edge. Innovation has been considered a competency of educated, design engineering, and a selected few employees that has become insufficient today. Corporations and organizations need innovation to develop customer-specific solutions in almost real time.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 584
Information Technology at C-Level
The issues, competencies, challenges and rewards of managing information technology in major enterprises at the Chief Information Officer/Chief Technology Officer level are examined in depth. The course will equip students with a fundamental awareness of what the enterprise and the profession expects from the highest levels of IT management. Readings, case studies and guided discussions will be supplemented by a series of guest lectures from-and discussions with-Chicago-area IT professional currently employed in these roles.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 585
Legal and Ethical Issues in Information Technology
Current legal issues in information technology are addressed including elements of contracting, payment systems and digital signatures, privacy concerns, intellectual property, business torts and criminal liability including hacking, computer trespass and fraud. Examination of ethical issues including privacy, system abuse, and ethical practices in information technology equip students to make sound ethical choices and resolve legal and moral issues that arise in information technology.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMM 586
Information Technology Auditing
Industry standard practices and standards in the auditing of information technology in an organization are addressed, with a particular emphasis on examination of IT governance, assets, controls, and control techniques. Specific areas covered will include the audit process, IT governance, systems and infrastructure life cycle management, IT service delivery and support, protection of information assets, and business continuity and disaster recovery. Students will examine case studies and complete hands-on exercises.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMO 517
Shell Scripting for System Administration
Focuses on preparation of shell scripts to enhance and streamline system administration tasks in all contemporary server operating systems. Scripting will be taught in both native and portable environments. The course will address shell programming, regular expressions, common and system-specific shell utilities and built-in commands, user defined and shell variables, flow control structures, shell functions, and the creation and execution of shell scripts. Homework and hands-on exercises will provide practical experience in contemporary server environments. Same as ITMO 417.
Prerequisite(s): [(ITMO 556)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMO 533
Enterprise Server Administration
Students learn to set up, maintain, and administer X86-based servers and associated networks using a contemporary industry-standard proprietary operating system. Topics include hardware requirements; software compatibility; system installation, configuration, and options and post-installation topics; administrative and technical practices required for system security; process management; performance monitoring and tuning; storage management; back-up and restoration of data; and disaster recovery and prevention. Also addressed is configuration and administration of common network and server services such as DNS, DHCP, remote access, email, basic virtualization, web and web services, and more.
Prerequisite(s): [(ITMO 540)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 540
Introduction to Data Networks and the Internet
This course covers current and evolving data network technologies, protocols, network components, and the networks that use them, focusing on the Internet and related LANs. The state of worldwide networking and its evolution will be discussed. This course covers the Internet architecture, organization, and protocols including Ethernet, 802.11, routing, the TCP/UDP/IP suite, DNS, SNMP, DHCP, and more. Students will be presented with Internet-specific networking tools for searching, testing, debugging, and configuring networks and network-connected host computers. There will be opportunities for network configuration and hands-on use of tools.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 541
Network Administration and Operations
Students learn the details, use, and configuration of network applications. Currently protocols and application technologies considered include SNMP, SMTP, IMAP, POP, MIME, BOOTP, DHCP, SAMBA, NFS, AFS, X, HTTP, DNS, NetBIOS, and CIFS/SMB. Windows workgroups and domains: file and printer sharing, remote access, and Windows networking are addressed. A research paper in the above topic areas is required.
Prerequisite(s): [(ITMO 540)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 542
Wireless Technologies and Applications
This course will provide students with the knowledge of wireless communication technologies. The course will focus on the 3G and 4G wireless networks such as UMTS, LTE, and WiMAX. Students will have the opportunity to study the different wireless networks architectures and major network elements including devices, base stations, base station controller, and core networks. Major topics of the course include air interfaces, protocols, session management, QoS, security, mobility, and handoff.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMO 544
Cloud Computing Technologies
Computing applications hosted on dynamically-scaled, virtual resources available as services are considered. Collaborative and non-collaborative "cloud-resident" applications are analyzed with respect to cost, device/location independence, scalability, reliability, security, and sustainability. Commercial and local cloud architectures are examined. A group-based integration of course topics will result in a project employing various cloud computing technologies.
Prerequisite(s): [(ITMD 510 and ITMO 556)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 545
Telecommunications Technology
This course introduces technologies underlying telecommunications and real-time communications systems and services. Topics will include: wire-line and fiber systems including those associated with the public switched telephone networks and cable service providers; wireless systems including cellular, WiFi and WiMAX. Methods and architectures for delivery of signaling, voice and video are introduced; analog telephone systems, digital telephone systems on circuit switched networks both wire-line and cellular; digital telecommunications on packet switched networks. Codecs and transformation of voice and video into digital formats are introduced. Physical and data-link layer protocols are studied with emphasis on how they carry voice and video. Channelization and multiple-access methods are introduced. Switching methods studied include circuit switching, virtual circuit switching and packet switching.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMO 546
Telecommunications Over Data Networks
This course covers a suite of application protocols known as Voice over IP (VoIP). It describes important protocols within that suite including RTP, SDP, MGCP and SIP and the architecture of various VoIP installations including on-net to on-net to PSATN and inter-domain scenarios. the functions of the Network Elements that play significant roles in this architecture will be defined. Examples of network elements that are currently available as products will be examined.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 547
Telecommunications Over Data Networks: Projects and Advanced Methods
Mentored projects focused on real-time media applications, systems and services. HTTP-based and SIP-based systems are studied; reference is made to RTCWeb, W3C and IETF specifications and initiatives. Topics may include web-based real-time media applications; web-conferencing and distributed class-room applications; communications systems using SIP and Web technologies; standards-based systems supporting emergency calls over IP backbone networks; metrics for performance characteristics of real-time systems; security of streaming media; interoperability/conformance testing of real-time applications and services. Students present/demonstrate projects in a public meeting. Students should have previous or concurrent experience with one or more of the following: SIP, HTTP, HTML, and scripting or coding languages.
Prerequisite(s): [(ITMO 546)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 550
Enterprise End-User System Administration
Students learn to set up, configure, and maintain end-user desktop and portable computers and devices in an enterprise environment using a contemporary proprietary operating system, including the actual installation of the operating system in a networked client-server environment. User account management, security, printing, disk configuration, and backup procedures are addressed with particular attention to coverage of networked applications. System installation, configuration, and administration issues as well as network file systems, network access, and compatibility with other operating systems are also addressed. Administration of central server resources associated with management and provisioning of end-user systems in workgroups, domains, or forests is also addressed.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 553
Open Source System Administration
Students learn to set up, configure, and administer an industry-standard open source server operating system including integration with client systems using a variety of operating systems in a mixed environment. Topics include hardware requirements; software compatibility; administrative and technical practices required for system security; process management; performance monitoring and tuning; storage management; back-up and restoration of data; and disaster recovery and prevention. Also addressed are configuration and administration of common network and server services such as DNS, DHCP, firewall, proxy, remote access, file and printer sharing, email, web, and web services as well as support issues for open source software.
Prerequisite(s): [(ITMO 540 and ITMO 556)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 554
Operating Systems Virtualization
This course will cover technologies allowing multiple instances of operating systems to be run on a single physical system. Concepts addressed will include hypervisors, virtual machines, paravirtualization and virtual appliances. Both server and desktop virtualization will be examined in detail, with brief coverage of storage virtualization and application virtualization. Business benefits, business cases and security implications of virtualization will be discussed. Extensive hands-on assignments and a group project will allow students to gain first-hand experience of this technology.
Prerequisite(s): [(ITMO 556)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 556
Introduction to Open Source Software
This course will cover the fundamental concepts and philosophy behind free and open source software (FOSS). The course will discuss open source and free software licensing; open source business strategies and impact; FOSS utilization in the enterprise; and development methodologies. Students will learn to set up and configure an industry-standard open source operating system, including system installation, and basic system administration; system architecture; package management; command?line commands; devices, filesystems, and the filesystem hierarchy standard. Also addressed are applications, shells, scripting and data management; user interfaces and desktops; administrative tasks; essential system services; networking fundamentals; and security, as well as support issues for open source software. Multiple distributions are covered with emphasis on the two leading major distribution forks.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMO 557
Storage Technologies
Modern enterprise data storage technologies and architectures are examined in depth. Topics include storage devices, file systems, storage networks, virtual storage, RAID, NAS, SAN, and other current enterprise-level storage models. Storage management, replication, deduplication, storage tiers, backups as well as fundamentals of business continuity, application workload, system integration, and storage/system administration are addressed. Specific knowledge and skills required to configure networked storage to include archive, backup, and restoration technologies are covered.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMS 518
Coding Security
This course examines security architecture elements within modern object-oriented programming languages that create the framework for secure programming. Analysis of components and services with their inherent strength and weaknesses give rise to common coding security challenges. An exploration of identity management, encryption services and common hacking techniques will enable the student's ability to develop secure code. Homework assignments and projects will reinforce theories taught.
Prerequisite(s): [(ITMD 510) OR (ITMD 512) OR (ITMD 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMS 528
Database Security
Students will engage in an in-depth examination of topics in data security including security considerations in applications & systems development, encryption methods, cryptography law, and security architecture & models.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMS 538
Cyber Forensics
This course will address methods to properly conduct a computer and/or network forensics investigation including digital evidence collection and evaluation and legal issues involved in network forensics. Technical issues in acquiring court-admissible chains of evidence using various forensic tools that reconstruct criminally liable actions at the physical and logical levels are also addressed. Technical topics covered include detailed analysis of hard disks, files systems (including FAT, NTFS and EXT), and removable storage media; mechanisms for hiding and detecting hidden information; and the hands-on use of powerful forensic analysis tools.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 539
Steganography
Digital steganography is the science of hiding covert information in otherwise innocent carrier files so that the observer is unaware that hidden information exists. This course studies both digital steganography and digital steganalysis (the science of discovering the existence of and extracting the covert information). In addition to understanding the science and the pathologies of specific carriers and hiding algorithms, students will have hands-on experience with tools to both hide and extract information. Carrier files such as image, audio, and video files will be investigated.
Prerequisite(s): [(ITMS 538) OR (ITMS 548)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 543
Vulnerability Analysis and Control
This course addresses hands-on ethical hacking, penetration testing, and detection of malicious probes and their prevention. It provides students with in-depth theoretical and practical knowledge of the vulnerabilities of networks of computers including the networks themselves, operating systems and important applications. Integrated with the lectures are laboratories focusing on the use of open source and freeware tools; students will learn in a closed environment to probe, penetrate and hack other networks.
Prerequisite(s): [(ITMO 540)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 548
Cyber Security Technologies
Prepares students for a role as a network security administrator and analyst. Topics include viruses, worms, other attack mechanisms, vulnerabilities and countermeasures, network security protocols, encryption, identity and authentication, scanning, firewalls, security tools, and organizations addressing security. A component of this course is a self-contained team project that, if the student wishes, can he extended into a full operational security system in a follow-course,
Prerequisite(s): [(ITMO 540)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 549
Cyber Security Technologies: Projects & Advanced Methods
Prepares students for a role as a network security analyst and developer and gives the student experience in developing a production security system. Topics may include computer and network forensics, advances in cryptography and security protocols and systems; operating system security, analysis of recent security attacks, vulnerability and intrusion detection, incident analysis and design and development of secure networks. This course includes a significant real world team project that results in an fully operational security system. Students should have previous experience with object-oriented and/or scripting languages.
Prerequisite(s): [(ITMS 539)]AND[(ITMS 548)]
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 555
Mobile Device Forensics
This course will address methods for recovering digital data or evidence and conducting forensic analysis of mobile devices such as smart phones and tablets. Various devices will be compared including iPhone, Android, and Blackberry. A brief review of Linux and related forensic tools. ANAND technology and mobile file systems will be discussed. Students will learn how to unlock and root mobile devices and recover data from actual mobile devices.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 557
Introduction to Cyber Warfare
Cyber warfare is defined as "warfare waged in cyberspace," which can include defending information and computer networks and deterring information attacks as well as denying an adversary's ability to do the same. It can include offensive information operations mounted against an adversary or even dominating information on the battlefield. Students participating in this discussion-based course will explore the current state of cyber security from national and international perspectives and consider cyber-based operations through the lens of a government pursuing strategic goals. How might their actions impact the industry's ability to conduct business operations? What does the current threat environment look like? The course will include extensive discussions and student presentations.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMS 558
Operating Systems Security
This course will address theoretical concepts of operating system security, security architectures of current operating systems, and details of security implementation using best practices to configure operating systems to industry security standards. Server configuration, system-level firewalls, file system security, logging, anti-virus and anti-spyware measures and other operating system security strategies will be examined.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMS 578
Cyber Security Management
In-depth examination of topics in the management of information technology security including access control systems & methodology, business continuity & disaster recovery planning, legal issues in information system security, ethics, computer operations security, physical security and security architecture & models using current standards and models.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMS 579
Topics in Information Security
This course will cover a particular topic in Information Security, varying from semester to semester, in which there is particular student or staff interest. This course may be taken more than once but only 9 hours of ITMS 579 credit may be applied to a degree.
Credit: Variable

ITMS 584
Governance, Risk, and Compliance
This course is an in-depth examination of topics in information technology/information security governance, risk, and compliance including information assurance policies, standards, and compliance as well as the examination of security risk analysis and the performance of systems certification and accreditation.
Prerequisite(s): [(ITMS 578)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMS 588
Incident Response, Disaster Recovery, and Business Continuity
Students learn to design and manage key business information security functions including incident response plans and incident response teams disaster recovery plans; and business continuity plans. Reporting, response planning and budgeting are all addressed. Students working in reams will prepare an incident response, disaster recovery, or business continuity plan for a real-world organizations such as a business or a government body or agency.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMT 514
Enterprise Application Architecture
This course examines current enterprise application architectures from the perspective of senior technology planners and managers. Topics such as models and patterns of enterprise application architecture, application virtualization, cloud application architectures, integration of custom application infrastructure with major vendor products, and full systems integration issues will be addressed.
Prerequisite(s): [(ITMD 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMT 531
Object-Oriented System Analysis, Modeling, and Design
This course will cover object oriented approaches to system analysis, data modeling and design that combine both process and data views of systems. Emphasis is given to practical problems and the techniques needed to create solutions in systems design.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMT 533
Operating System Design Implementation
This course introduces students to the fundamental principles of operating systems design and gives them hands-on experience with real operating systems installation, design, and implementation. The students apply what they learn about operation systems design to practical implementation by modifying and extending the MINIX Operating System. MS Windows and LINUX are briefly discussed as case studies.
Prerequisite(s): [(ITMD 512)]
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMT 535
Data Center Architecture
The course deals with building integrated data center information infrastructures, including facility, hardware, software, and network components as solutions to particular enterprise information management needs and requirements. Students will learn critical elements of modern data center design including physical plant construction; network infrastructure; data storage technologies; power provisioning and conditioning; environmental controls and HVAC; system and physical security; modular component use; and planning for growth.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMT 537
Instructional Technologies
In this course students will create, assess, and deploy current technologies used for K-College instruction and corporate training environments. Topics covered include developing training materials, courses, individualized instruction, websites, multimedia projects, and on-line instruction in educational settings. focus will be given to modern programming environments and models for developing instructional materials.
Lecture: 3 **Lab:** 0 **Credits:** 3

ITMT 593
Embedded Systems
This course introduces embedded systems concepts and technology, illustrates the trade-offs which occur as part of embedded systems design, as well as providing practical applications of embedded systems technology. Particular emphasis is given to embedded systems hardware, software and development tools. The course labs include hands-on development of several stand-alone embedded applications using development tools such as compilers, simulators and evaluation boards. Prerequisite: ITM 301 or equivalent computer architecture course; C/C++ programming experience.
Lecture: 2 **Lab:** 2 **Credits:** 3

ITMT 594
Special Projects in Information Technology
Special projects.
Credit: Variable

ITMT 595
Topics in Information Technology
This course will cover a particular topic, varying from semester to semester, in which there is particular student or staff interest.
Credit: Variable

ITMT 596
Graduate Honors Studies in Information Technology
Graduate honors project, thesis or whitepaper. Prerequisites: Graduate honors status and consent of the instructor.
Credit: Variable

ITMT 597
Special Problems in Information Technology
Independent study and project.
Credit: Variable

TECH 565
Introduction to Social Commerce
Provides an introduction and basic knowledge of social commerce to help students develop a practical understanding of the design, construction, market readiness, and synergistic integration of a business mobile application. The course will provide a practitioner focus that will benefit students in a start-up or company/corporate setting.
Lecture: 3 **Lab:** 0 **Credits:** 3

TECH 580
Topics in the Management of Technology
This course will cover a particular topic, varying from semester to semester, in which there is particular student or staff interest. This course may be taken more than once but only 9 hours of TECH 580 credit may be applied to a degree.
Credit: Variable

TECH 581
Consulting for Technical Professionals
This course explores the application of technology and technical management skills to working with business, industry, or various professions in solving specific problems for an organization as an internal or external consultant. Students learn how to involve clients in all phases of problem identification and solution with the goal that, at the end of a consulting assignment, the clients are able to sustain the necessary changes in their organization. Particular attention is paid to managing expectations among change agents, managers, executives, technical professionals, and other members of the organization. The course will cover the most critical, high-level, functional frameworks used by top consulting firms today as well as the tools commonly used by consulting professionals.
Lecture: 3 **Lab:** 0 **Credits:** 3

TECH 597
Special Problems in Technology
Independent study and projects in applied technology that are multi/cross-disciplinary not tied to a specific department.
Credit: Variable

Master of Cyber Forensics and Security

At the conclusion of their studies, graduates of the Master of Cyber Forensics and Security degree should be able to:

- Design and implement a comprehensive enterprise security program using both policy and technology to implement technical, operational, and managerial controls.
- Comprehensively investigate information security incidents and violation of law using computer resources in a manner such that all evidence is admissible in a court of law.
- Technically secure enterprise information assets and resources to deter, detect, and prevent the success of attacks and intrusions.

Illinois Institute of Technology has been designated as a National Center of Academic Excellence in Cyber Defense Education by the National Security Agency and the U.S. Department of Homeland Security. This designation results from meeting stringent Center of Academic Excellence criteria and mapping of information technology and management curricula to a core set of cyber defense knowledge units. Students attending Center of Academic Excellence in Cyber Defense Education institutions are eligible to apply for scholarships and grants through the Department of Defense Information Assurance Scholarship Program and the Federal Cyber Service Scholarship for Service Program. This designation reflects Illinois Institute of Technology's commitment to producing professionals with cyber defense expertise for the nation.

Curriculum

Required Core Courses			(18) [1]
ITMS 538	Cyber Forensics		3
ITMS 543	Vulnerability Analysis and Control		3
ITMS 548	Cyber Security Technologies		3
ITMS 578	Cyber Security Management		3
LAW 273	Evidence		3
Select a minimum of one course from the following:			3
ITMS 539	Steganography	3	
ITMS 549	Cyber Security Technologies: Projects & Advanced Methods	3	
Elective Courses			(11-12)
Select a minimum of 9 credit hours from the following:			9
Any 500-level ITMS course not listed in required courses above. [2]			
ITMM 585	Legal and Ethical Issues in Information Technology	3	
ITMM 586	Information Technology Auditing	3	
ITMO 556	Introduction to Open Source Software	3	
ITMT 594	Special Projects in Information Technology	3	
ITMT 597	Special Problems in Information Technology	3	
Select a minimum of one course from the following: [3]			2-3
LAW 240	National Security Law	2	
LAW 478	Computer & Network Privacy	3	
LAW 495	Electronic Discovery	2	

Minimum degree credits required: 30

1. Core course requirements may be waived upon presentation of evidence of equivalent coursework, certification, or experience. Approval of waivers will be made by the student's adviser or the ITM associate chair.
2. ITMS 579 may be taken more than once.
3. LAW electives not listed above may be substituted as approved by the student's adviser or the ITM associate chair.

Master of Information Technology and Management

At the conclusion of their studies, graduates of this degree should be able to:

- Deliver optimal technical and policy technology solutions for the problems of business, industry, government, non-profit organizations, and individuals in each student's particular area of focus.
- Work with, lead, and manage teams in an enterprise environment to collaboratively arrive at optimal technology solutions.
- Manage and deploy information resources applicable to each student's particular area of focus in an enterprise setting.

All students are required to complete a minimum of three core courses. These core courses will ensure an ability to develop software applications at a competent level using a contemporary programming language, the capability to employ and deploy appropriate system technologies, and a grasp of business development knowledge appropriate to the discipline. Students completing a specialization are required to complete three core courses, selecting one from each of the core subjects. Students electing not to complete a specialization must complete at least one course from each of the seven core subject topic areas. Advisers will assist students in the selection of core courses most relevant to their interests and career goals.

The specializations are meant to guide students in their course selection, allowing them to focus on a particular area of information technology, depending on their interests, background, and career goals. Alternative courses in each specialization may be available at the discretion of the student's adviser.

Curriculum

Master of Information Technology & Management (without Specialization)

Programming	(3)
Select 3 credit hours of Programming courses (p. 397)	3
Application Development	(3)
Select 3 credit hours of Application Development courses (p. 397)	3
Information Systems Technologies	(3)
Select 3 credit hours of Information Systems Technologies courses (p. 397)	3
Information Technology Architectures	(3)
Select 3 credit hours of Information Technology Architectures courses (p. 397)	3
Design	(3)
Select 3 credit hours of Design courses (p. 397)	3
Management	(3)
Select 3 credit hours of Management courses (p. 397)	3
Innovation	(3)
Select 3 credit hours of Innovation courses (p. 398)	3
Elective Courses	(9)
Select 9 credit hours	9
Total Credit Hours	30

Master of Information Technology & Management (with Specialization)

Software Development	(3)
Select 3 credit hours of Software Development courses (p. 397)	3
System Technologies	(3)
Select 3 credit hours of System Technologies courses (p. 397)	3
Business Development	(3)
Select 3 credit hours of Business Development courses (p. 397)	3
Specialization Courses	(21)
Select 21 credit hours from approved specialization courses [1]	21
Total Credit Hours	30

1 Students may select courses in order to fulfill a desired specialization. See Specializations tab on this page for more details. Courses taken to meet the requirements of a specialization may also count toward core course requirements.

Graduate Core Courses by Subject and Topic

The following courses comprise the graduate core courses:

Subject: Software Development

Topic: Programming

ITMD 510	Object-Oriented Application Development	3
ITMD 512	Structured and Systems Programming	3
ITMD 515	Advanced Software Programming	3

Subject: System Technologies

Topic: Application Development

ITMD 553	Enterprise Intelligent Device Applications	3
ITMD 554	Mass-Market Intelligent Device Applications	3
ITMD 555	Open-Source Intelligent Device Applications	3
ITMD 565	Rich Internet Applications	3
ITMD 566	Service-Oriented Architectures	3
ITMT 593	Embedded Systems	3

Topic: Information Systems Technologies

ITMO 533	Enterprise Server Administration	3
ITMO 553	Open Source System Administration	3
ITMO 556	Introduction to Open Source Software	3
ITMS 558	Operating Systems Security	3

Topic: Information Technology Architectures

ITMO 540	Introduction to Data Networks and the Internet	3
ITMO 554	Operating Systems Virtualization	3
ITMS 548	Cyber Security Technologies	3
ITMT 535	Data Center Architecture	3

Subject: Business Development

Topic: Design

ITMD 511	Application Development Methodologies	3
ITMD 532	UML-Based Software Development	3
ITMD 534	Human and Computer Interaction	3
ITMT 531	Object-Oriented System Analysis, Modeling, and Design	3

Topic: Management

ITMM 570	Fundamentals of Management for Technology Professionals	3
ITMM 571	Project Manangement for Information Technology Management	3
ITMM 574	Information Technology Management Frameworks	3
ITMM 575	Networking and Telecommunications Management	3

ITMS 578	Cyber Security Management	3

Topic: Innovation

ITMM 581	Information Technology Entrepreneurship	3
ITMM 582	Business Innovation	3
ITMD 535	Human-Computer Interaction Design	3

Note: Core courses that also apply to a specialization will still fulfill the core course requirement.

Specializations

Computer and Information Security

Required Courses			(21)
ITMO 540	Introduction to Data Networks and the Internet		3
ITMO 556	Introduction to Open Source Software		3
ITMS 548	Cyber Security Technologies		3
ITMS 578	Cyber Security Management		3
Select a minimum of one course from the following:			3
ITMS 539	Steganography	3	
ITMS 549	Cyber Security Technologies: Projects & Advanced Methods	3	
Select a minimum of 3 credit hours from the following:			3
Any 500-level ITMS elective [1]		3	
Select a minimum of 3 credit hours from the following:			3
Any 500-level ITMO elective		3	
Any 500-level ITMS elective		3	
ITMM 586	Information Technology Auditing	3	
Total Credit Hours			21

1 ITMS 579 may only be taken once as part of this requirement

Data Center Operations and Management

Required Courses			(21)
ITMO 540	Introduction to Data Networks and the Internet		3
ITMO 554	Operating Systems Virtualization		3
ITMO 556	Introduction to Open Source Software		3
ITMM 576	Data Center Management		3
ITMT 535	Data Center Architecture		3
Select 6 credit hours from the following:			6
ITMD 526	Data Warehousing	3	
ITMM 574	Information Technology Management Frameworks	3	
ITMO 533	Enterprise Server Administration	3	
ITMO 544	Cloud Computing Technologies	3	
ITMO 546	Telecommunications Over Data Networks	3	
ITMO 553	Open Source System Administration	3	
ITMO 557	Storage Technologies	3	
ITMS 548	Cyber Security Technologies	3	
ITMS 578	Cyber Security Management	3	
ITMS 588	Incident Response, Disaster Recovery, and Business Continuity	3	
Total Credit Hours			21

Data Management

Required Courses			(21)
ITMD 523	Advanced Topics in Data Management		3
ITMD 526	Data Warehousing		3
ITMD 527	Data Analytics		3
ITMS 528	Database Security		3
ITMT 531	Object-Oriented System Analysis, Modeling, and Design		3
Select a minimum of 6 credit hours from the following:			6
ITMD 521	Client/Server Technologies and Applications	3	
ITMD 525	Topics in Data Science and Management	3	
ITMD 529	Advanced Data Analytics	3	
ITMD 566	Service-Oriented Architectures	3	
ITMM 574	Information Technology Management Frameworks	3	
ITMO 557	Storage Technologies	3	
ITMS 578	Cyber Security Management	3	
Total Credit Hours			21

Digital Systems Technology

Required Courses			(21)
ITMD 512	Structured and Systems Programming		3
ITMO 556	Introduction to Open Source Software		3
ITMT 533	Operating System Design Implementation		3
ITMT 593	Embedded Systems		3
Select a minimum of 3 credit hours from the following:			3
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
Select a minimum of 3 credit hours from the following:			3
ITMD 511	Application Development Methodologies	3	
ITMD 556	Intelligent Device Projects	3	
ITMO 542	Wireless Technologies and Applications	3	
ITMO 544	Cloud Computing Technologies	3	
Select a minimum of 3 credit hours from the following:			3
ITMD 545	Web Real-Time Communications	3	
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
ITMD 556	Intelligent Device Projects	3	
ITMD 565	Rich Internet Applications	3	
ITMO 540	Introduction to Data Networks and the Internet	3	
ITMO 541	Network Administration and Operations	3	
ITMO 546	Telecommunications Over Data Networks	3	
INTM 522	Computers in Industry	3	
TECH 565	Introduction to Social Commerce	3	
Total Credit Hours			21

IT Management and Entrepreneurship

Required Courses			(21)
ITMD 534	Human and Computer Interaction		3
ITMM 570	Fundamentals of Management for Technology Professionals		3
ITMM 581	Information Technology Entrepreneurship		3
ITMM 582	Business Innovation		3

Select 3 credit hours from the following:			3
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
Select 6 credit hours from the following:			6
Any 500-level ITMM elective			
ITMD 556	Intelligent Device Projects	3	
ITMS 578	Cyber Security Management	3	
TECH 565	Introduction to Social Commerce	3	
TECH 581	Consulting for Technical Professionals	3	
Total Credit Hours			21

Management Information Systems

Required Courses			(21)
ITMD 521	Client/Server Technologies and Applications		3
ITMD 523	Advanced Topics in Data Management		3
ITMD 566	Service-Oriented Architectures		3
ITMM 574	Information Technology Management Frameworks		3
Select a minimum of 6 credit hours from the following:			6
ITMM 572	Process Engineering for Information Technology Managers	3	
ITMM 586	Information Technology Auditing	3	
ITMO 554	Operating Systems Virtualization	3	
ITMT 531	Object-Oriented System Analysis, Modeling, and Design	3	
Select a minimum of 3 credit hours from the following:			3
INTM 522	Computers in Industry	3	
ITMD 525	Topics in Data Science and Management	3	
ITMD 526	Data Warehousing	3	
ITMD 527	Data Analytics	3	
ITMD 529	Advanced Data Analytics	3	
ITMD 532	UML-Based Software Development	3	
ITMM 537	Service Level Agreements	3	
ITMO 544	Cloud Computing Technologies	3	
ITMO 557	Storage Technologies	3	
ITMS 528	Database Security	3	
TECH 565	Introduction to Social Commerce	3	
TECH 581	Consulting for Technical Professionals	3	
Total Credit Hours			21

Software Development

Required Courses			(21)
ITMD 510	Object-Oriented Application Development		3
ITMD 515	Advanced Software Programming		3
ITMD 536	Software Testing and Maintenance		3
ITMM 571	Project Manangement for Information Technology Management		3
Select a minimum of 6 credit hours from the following:			6
ITMD 511	Application Development Methodologies	3	
ITMD 513	Open Source Programming	3	
ITMD 532	UML-Based Software Development	3	
ITMD 565	Rich Internet Applications	3	
Select a minimum of 3 credit hours from the following:			3
ITMD 511	Application Development Methodologies	3	
ITMD 512	Structured and Systems Programming	3	

ITMD 513	Open Source Programming	3	
ITMD 519	Topics in Software Development	3	
ITMD 532	UML-Based Software Development	3	
ITMD 534	Human and Computer Interaction	3	
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
ITMD 556	Intelligent Device Projects	3	
ITMD 565	Rich Internet Applications	3	
ITMM 572	Process Engineering for Information Technology Managers	3	
ITMS 518	Coding Security	3	
ITMT 531	Object-Oriented System Analysis, Modeling, and Design	3	
TECH 565	Introduction to Social Commerce	3	
Total Credit Hours			21

System Administration

Required Courses			(21)
ITMO 540	Introduction to Data Networks and the Internet		3
ITMO 541	Network Administration and Operations		3
ITMO 556	Introduction to Open Source Software		3
Select a minimum of 6 credit hours from the following:			6
ITMO 533	Enterprise Server Administration	3	
ITMO 550	Enterprise End-User System Administration	3	
ITMO 553	Open Source System Administration	3	
Select a minimum of 6 credit hours from the following:			6
ITMM 537	Service Level Agreements	3	
ITMM 571	Project Manangement for Information Technology Management	3	
ITMM 574	Information Technology Management Frameworks	3	
ITMM 575	Networking and Telecommunications Management	3	
ITMO 517	Shell Scripting for System Administration	3	
ITMO 533	Enterprise Server Administration	3	
ITMO 544	Cloud Computing Technologies	3	
ITMO 550	Enterprise End-User System Administration	3	
ITMO 553	Open Source System Administration	3	
ITMO 554	Operating Systems Virtualization	3	
ITMO 557	Storage Technologies	3	
ITMS 558	Operating Systems Security	3	
Total Credit Hours			21

Systems Analysis

Required Courses			(21)
ITMD 511	Application Development Methodologies		3
ITMD 534	Human and Computer Interaction		3
ITMD 536	Software Testing and Maintenance		3
ITMM 572	Process Engineering for Information Technology Managers		3
ITMT 531	Object-Oriented System Analysis, Modeling, and Design		3
Select a minimum of 6 credit hours from the following:			6
INTM 522	Computers in Industry	3	
ITMD 532	UML-Based Software Development	3	
ITMM 574	Information Technology Management Frameworks	3	
ITMM 575	Networking and Telecommunications Management	3	
ITMM 586	Information Technology Auditing	3	

ITMS 578	Cyber Security Management	3	
TECH 581	Consulting for Technical Professionals	3	
Total Credit Hours			21

Voice and Data Communication Technology

Required Courses			(21)
ITMD 545	Web Real-Time Communications		3
ITMO 540	Introduction to Data Networks and the Internet		3
ITMO 546	Telecommunications Over Data Networks		3
ITMO 556	Introduction to Open Source Software		3
Select a minimum of 6 credit hours from the following:			6
ITMO 541	Network Administration and Operations	3	
ITMO 542	Wireless Technologies and Applications	3	
ITMO 544	Cloud Computing Technologies	3	
ITMO 547	Telecommunications Over Data Networks: Projects and Advanced Methods	3	
Select a minimum of 3 credit hours from the following:			3
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
ITMD 565	Rich Internet Applications	3	
ITMM 571	Project Manangement for Information Technology Management	3	
ITMM 575	Networking and Telecommunications Management	3	
ITMO 541	Network Administration and Operations	3	
ITMO 542	Wireless Technologies and Applications	3	
ITMO 547	Telecommunications Over Data Networks: Projects and Advanced Methods	3	
ITMS 543	Vulnerability Analysis and Control	3	
ITMS 548	Cyber Security Technologies	3	
ITMS 555	Mobile Device Forensics	3	
TECH 565	Introduction to Social Commerce	3	
Total Credit Hours			21

Web Design and Application Development

Required Courses			(21)
ITMD 534	Human and Computer Interaction		3
ITMD 562	Web Site Application Development		3
ITMD 565	Rich Internet Applications		3
ITMD 567	Web Systems Integration		3
ITMM 582	Business Innovation		3
Select a minimum of 6 credit hours from the following:			6
COM 525	User Experience Research and Evaluation	3	
ITMD 513	Open Source Programming	3	
ITMD 515	Advanced Software Programming	3	
ITMD 519	Topics in Software Development	3	
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
ITMD 563	Intermediate Web Application Development	3	
ITMD 564	Advanced Web Application Development	3	
ITMD 566	Service-Oriented Architectures	3	
ITMD 569	Topics in Application Development	3	
TECH 565	Introduction to Social Commerce	3	
Total Credit Hours			21

Certificate in Advanced Software Development

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will enhance their skills as a software developer.

Curriculum

Required Courses			(12)
ITMD 515	Advanced Software Programming		3
ITMM 571	Project Manangement for Information Technology Management [1]		3
Select a minimum of two courses from the following:			6
ITMD 511	Application Development Methodologies	3	
ITMD 513	Open Source Programming	3	
ITMD 519	Topics in Software Development	1-6	
ITMD 532	UML-Based Software Development	3	
ITMD 534	Human and Computer Interaction	3	
ITMD 536	Software Testing and Maintenance	3	
ITMO 556	Introduction to Open Source Software	3	
ITMS 518	Coding Security	3	
Total Credit Hours			12

1 Students who have already completed coursework, training, or certification equivalent to ITMM 571 may substitute a fourth course from the above list.

Certificate in Cyber Security Management

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for careers in the management of information security.

Curriculum

Required Courses			(12)
ITMS 548	Cyber Security Technologies		3
ITMS 578	Cyber Security Management		3
Select a minimum of two courses from the following:			6
ITMM 586	Information Technology Auditing	3	
ITMS 543	Vulnerability Analysis and Control	3	
ITMS 579	Topics in Information Security	1-6	
ITMS 588	Incident Response, Disaster Recovery, and Business Continuity	3	
Total Credit Hours			12

Certificate in Cyber Security Technologies

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for careers in computer and network security technologies and to deal with the challenging computer and network security problems facing society.

Curriculum

Required Courses			(12)
ITMS 543	Vulnerability Analysis and Control		3
ITMS 548	Cyber Security Technologies		3
Select a minimum of two courses from the following:			6
ITMS 518	Coding Security	3	
ITMS 528	Database Security	3	
ITMS 538	Cyber Forensics	3	
ITMS 539	Steganography	3	
ITMS 549	Cyber Security Technologies: Projects & Advanced Methods	3	
ITMS 555	Mobile Device Forensics	3	
ITMS 558	Operating Systems Security	3	
Total Credit Hours			12

Certificate in Data Center Operations and Management

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for a career in data center operations.

Curriculum

Required Courses			(12)
ITMM 576	Data Center Management		3
ITMO 540	Introduction to Data Networks and the Internet		3
ITMO 554	Operating Systems Virtualization		3
ITMT 535	Data Center Architecture		3
Students who have already completed coursework, training, or certification equivalent to ITMO 540 may substitute a fourth course from the list below.			
ITMO 544	Cloud Computing Technologies	3	
ITMO 557	Storage Technologies	3	
ITMS 548	Cyber Security Technologies	3	
ITMS 588	Incident Response, Disaster Recovery, and Business Continuity	3	
Total Credit Hours			12

Certificate in Data Management and Analytics

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for careers in data management and analytics.

Curriculum

Required Courses			(12)
ITMD 421	Data Modeling and Applications [1]		3
ITMD 422	Advanced Database Management		3
ITMD 527	Data Analytics		3
Select a minimum of one course from the following:			3
ITMD 526	Data Warehousing	3	
ITMD 529	Advanced Data Analytics	3	
ITMS 528	Database Security	3	
ITMT 531	Object-Oriented System Analysis, Modeling, and Design	3	
Total Credit Hours			12

1 Students who have already completed coursework, training, or certification equivalent to ITMD 421 may substitute a fourth course from the above list.

Certificate in Digital Voice and Data Communication Technologies

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for careers in digital voice and data communications.

Curriculum

Required Courses			(12)
ITMO 540	Introduction to Data Networks and the Internet [1]		3
ITMO 545	Telecommunications Technology		3
ITMO 546	Telecommunications Over Data Networks		3
Select a minimum of one course from the following:			3
ITMM 575	Networking and Telecommunications Management	3	
ITMO 541	Network Administration and Operations	3	
ITMO 547	Telecommunications Over Data Networks: Projects and Advanced Methods	3	
Total Credit Hours			12

1 Students who have already completed coursework, training, or certification equivalent to ITMO 540 may substitute a fourth course from the above list.

Certificate in Information Technology Innovation, Leadership, and Entrepreneurship

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them to be leaders, innovators, and entrepreneurs in the field of information technology.

Curriculum

Required Courses			(12)
ITMM 571	Project Manangement for Information Technology Management [1]		3
ITMM 581	Information Technology Entrepreneurship		3
ITMM 582	Business Innovation		3
Select a minimum of one course from the following:			3
Any ITMM Elective			
INTM 511	Industrial Leadership	3	
INTM 515	Advanced Project Management	3	
INTM 522	Computers in Industry	3	
INTM 543	Purchasing	3	
TECH 581	Consulting for Technical Professionals	3	
Total Credit Hours			12

1 Students who have already completed coursework, training, or certification equivalent to ITMM 571 may substitute a fourth course from the above list. Only one INTM course may be applied to the certificate.

Certificate in System Administration

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for a career as a systems administrator.

Curriculum

Select one of the following:			6
ITMO 456 & ITMO 553	Introduction to Open Source Operating Systems and Open Source System Administration	6	
ITMO 550 & ITMO 533	Enterprise End-User System Administration and Enterprise Server Administration	6	
Select a minimum of two courses from the following:			6
ITMM 571	Project Manangement for Information Technology Management	3	
ITMO 544	Cloud Computing Technologies	3	
ITMO 554	Operating Systems Virtualization	3	
ITMS 558	Operating Systems Security	3	
Total Credit Hours			12

Certificate in Systems Analysis

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for a career as a systems analyst.

Curriculum

Required Courses			(12)
ITMM 571	Project Manangement for Information Technology Management [1]		3
ITMM 572	Process Engineering for Information Technology Managers		3
ITMT 531	Object-Oriented System Analysis, Modeling, and Design		3
Select a minimum of one course from the following:			3
INTM 522	Computers in Industry	3	
ITMD 511	Application Development Methodologies	3	
ITMD 532	UML-Based Software Development	3	
ITMD 534	Human and Computer Interaction	3	
ITMD 536	Software Testing and Maintenance	3	
TECH 581	Consulting for Technical Professionals	3	
Total Credit Hours			12

1. Students who have already completed coursework, training, or certification equivalent to ITMM 571 may substitute a fourth course from the above list.

Certificate in Web Design and Application Development

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program. Applicants should have a bachelor's degree from an accredited college or university; the degree need not be in an information technology or a computer-related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

This program is designed for students seeking knowledge that will prepare them for careers in web design and application development.

Curriculum

Required Courses			(12)
ITMD 562	Web Site Application Development		3
ITMD 565	Rich Internet Applications		3
Select a minimum of two courses from the following:			6
ITMD 534	Human and Computer Interaction	3	
ITMD 553	Enterprise Intelligent Device Applications	3	
ITMD 554	Mass-Market Intelligent Device Applications	3	
ITMD 555	Open-Source Intelligent Device Applications	3	
ITMD 563	Intermediate Web Application Development	3	
ITMD 564	Advanced Web Application Development	3	
ITMD 566	Service-Oriented Architectures	3	
ITMD 567	Web Systems Integration	3	
ITMD 569	Topics in Application Development	3	
Total Credit Hours			12

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Siva K. Balasubramanian

Faculty with Research Interests
For more information regarding faculty visit the Stuart School of Business website.

Business at Illinois Institute of Technology

Stuart School of Business provides intellectually rigorous business and management education at all levels, from baccalaureate to doctoral. All Stuart programs are designed to educate tomorrow's global innovators through the unique concept of strategic competitiveness. Constructs including creativity, innovation, entrepreneurship, incisive decision-making, leadership, and sustainability are interwoven throughout coursework and professional development opportunities, offering students thorough preparation for the challenges of the Next Economy.

Established in 1969 with a gift from Illinois Institute of Technology alumnus and Chicago financier Harold Leonard Stuart, Stuart offers a wide range of challenging business and management programs taught from a practical perspective, with an emphasis on analytic skills and the relation between business, management, and technology. AACSB-accredited programs include the M.B.A., Ph.D., several industry-responsive master's programs, and one bachelor of science in business program. Stuart also offers a Master of Public Administration (M.P.A.) degree and five co-terminal programs.

Stuart faculty, in addition to their scholarly and teaching activities, are consultants to major national and international corporations. Their expertise has been called upon by local and federal government agencies, including the Environmental Protection Agency, National Institute of Standards and Technology, Metropolitan Sanitary District, Department of Housing and Urban Development, and Department of Energy. Many Stuart students are also working professionals from Chicago's preeminent business, public, and finance communities.

Job placement and career advancement are very important at Stuart. Stuart Student Affairs enables students to find professional success through the Stuart Career Management Center, Stuart Academic Advising, Stuart's unique Advancing Career and Education (ACE) workplace immersion program, and the Professional Communication Advancement program. Stuart is committed to creating well-rounded students who are not only armed with expert academic knowledge, but who also possess the interpersonal and communication skills that are critical to academic and professional success.

Stuart operates on a semester academic calendar consisting of two semesters beginning in August and January and a summer session beginning in May. Because many Stuart students work full time, graduate classes are regularly offered on weekday evenings as well as being offered during the day.

Research at Stuart

Faculty at Stuart School of Business engage in dynamic, collaborative research across disciplines. Focus areas include high frequency finance, sustainable enterprise, management science, and marketing analytics. Stuart's research centers engage with industry partners on research projects and programming to meet the needs of the next economy. For more information about research at Stuart School of Business, contact Siva Balasubramanian at sivakbalas@stuart.iit.edu.

Illinois Institute of Technology Entrepreneurship Academy

The Illinois Institute of Technology Entrepreneurship Academy (EA) provides distinctive and relevant education that emphasizes entrepreneurial thinking among students, alumni, and university stakeholders who interact with developing and existing businesses.

The Center for Strategic Competitiveness

The Center for Strategic Competitiveness develops global partnerships to enhance innovation and creativity, and is the foundation for Stuart's strategically competitive curriculum. The center's mission is to develop strategic competitiveness into an approach to business that will enhance the ability of individuals, organizations, and governmental units to respond proactively and innovatively to global market challenges in the next economy.

The Center for Financial Innovation

Financial innovation has been vigorously debated since the financial crisis of 2008. The Center for Financial Innovation (CFI) takes a comprehensive and objective look at the history of financial innovation, providing a central location for scholars, practitioners, media, and the general public to explore the many innovations that serve as the foundation for our global financial systems. The center will provide data, video interviews, and an Encyclopedia of Financial Innovation through the center's website.

Formerly named the Center for Financial Markets, and established in 1998 as the Center for Law and Financial Markets, the CFI has evolved from the vision of John (Jack) Wing, a financial and educational innovator. Jack Wing served as chairman of Chicago Corp., of ABN AMRO Inc., trustee of Illinois Institute of Technology, and the first director of the Center for Law and Financial Markets.

Dual Degree Programs

Several dual-degree programs are offered, including programs in which enrollees are eligible to earn a law degree from Chicago-Kent College of Law. To help plan a program of study, students will be assigned advisers from both programs in which they are studying. Simultaneous enrollment is required for varying periods of time, depending on the program. Students should consult advisers from both programs for further information. Candidates for a dual-degree program must apply to and be accepted by each program separately. Current LSAT scores are required for admission to Chicago-Kent College of Law. Current GMAT or GRE scores are required by the Stuart School of Business, but current LSAT scores may be substituted in some programs. Interested students should contact program advisers from either program for other specific requirements.

All graduate programs in business are subject to continuous improvements including dual-degree programs. Prospective students are urged to refer to the Stuart home page for the most current description of all programs and degree requirements.

M.B.A./M.P.A.

The Master of Business Administration/Master of Public Administration program is ideal for students who want to work in both public and private sector management, and/or who expect to move between business and government positions in their careers. The curriculum consists of twelve M.B.A. and nine M.P.A. courses, reducing degree requirements by six courses.

M.B.A./M.S. (Choose from M.S. Finance, M.S. Marketing Analytics, M.S. Sustainability Management)

Combine your Master of Business Administration with one of our specialized M.S. degree programs in finance, marketing analytics, or sustainability management. Dual enrollment can reduce degree requirements by up to six courses.

M.B.A./J.D.

The Master of Business Administration/Juris Doctorate program offers a competitive advantage for legal professionals who need a solid understanding of business practices, especially for corporate attorneys or legal/management consultants. Dual enrollment can reduce degree requirements by as many as ten courses.

M.P.A./J.D.

The Master of Public Administration/Juris Doctorate degree is particularly valuable for administrators who need a greater understanding of legislation, rules, and judicial decisions. Dual enrollment can reduce degree requirements by up to five courses.

M.S. Finance/J.D.

The Master of Science in Finance/Juris Doctorate degree is designed to prepare students for careers in the legal profession with emphasis on finance. Dual enrollment can reduce degree requirements by up to nine courses.

M.S. Sustainability Management/J.D.

The Master of Science in Sustainability Management/Juris Doctorate degree is designed to prepare students for careers in the legal profession with emphasis on environmental issues and sustainable business practices. Dual enrollment can reduce degree requirements by up to nine courses.

M.B.A./M.Des.

The Master of Business Administration/Master of Design degree combines advanced methods for exploring new theories of design with an understanding of the business applications of technology and analytic methods. Dual enrollment can reduce degree requirements by up to nine courses.

Admission Requirements

Admission to the Stuart School of Business is based on a profile combination of undergraduate GPA, GMAT test scores (some M.S. programs accept GRE scores in place of GMAT scores), and work experience. Applicants to all master's programs, including the M.B.A., must have, or are expected to complete prior to enrollment, a four year undergraduate degree from an accredited institution. Applications are accepted throughout the year and part-time students may enter most programs at the beginning of any semester. Applicants must submit essays, letters of recommendation, official transcripts, a recent GMAT score report, and a summary of work experience. Applicants from non-English-speaking countries must also submit TOEFL (Test of English as a Foreign Language), PTE (Pearson Test of English), or IELTS (International English Language Testing System) scores, unless they received an undergraduate or graduate degree from an accredited U.S. institution. English language proficiency assessment is required of all international students. Assessment results will determine which, if any, professional communication advancement courses will be required in addition to the main academic program courses for graduation.

Admission to the Master of Public Administration degree requires an essay, two letters of recommendation, official transcripts and a summary of work experience if applicable. GRE or GMAT scores are not required, but may be submitted. The same requirements as for business programs apply for applicants from non-English speaking countries for TOEFL, PTE, or IELTS.

Applicants to the Ph.D. in Management Science must have a competitive score on the GMAT or GRE (316 or above for GRE and 650 or above for GMAT).

The following are additional requirements for each of the four tracks within the Ph.D. in Management Science:

1. M-track with Finance concentration: a graduate degree considered equivalent to the M.S. in Finance degree offered at the Stuart School
2. M-track with Analytics concentration: a graduate degree considered equivalent to the M.S. in Marketing Analytics degree offered at the Stuart School
3. UG-track with Finance or Analytics concentrations: an undergraduate degree with an outstanding record of academic accomplishments

Refer to admission.iit.edu/graduate for complete details.

Degrees Offered

- Master of Business Administration (M.B.A.) (p. 441)
- Master of Public Administration (p. 444)
- Master of Technological Entrepreneurship (p. 445)
- Master of Science in Finance (p. 445)
- Master of Science in Management Science (p. 447)
- Master of Science in Marketing Analytics (p. 447)
- Master of Science in Sustainability Management (p. 448)
- Doctor of Philosophy in Management Science (p. 449)

Dual Degree Programs

- M.B.A./M.S. in Finance
- M.B.A./M.S. in Marketing Analytics
- M.B.A./Master of Public Administration
- M.B.A./M.S. in Sustainability Management

With the Institute of Design

- Master of Design/Master of Business Administration (p. 325)

With the Chicago-Kent College of Law

- M.B.A./J.D. (p. 178)
- Master of Public Administration/J.D. (p. 178)
- M.S. in Finance/J.D. (p. 178)
- M.S. in Sustainability Management/J.D. (p. 178)

Joint Degree Program

- Master of Mathematical Finance (with Applied Mathematics) (p. 442)

Co-Terminal Options

Bachelor of Science/Master of Public Administration (B.S./M.P.A.)

The B.S./M.P.A. co-terminal degree program allows students to complete both an undergraduate business administration (B.S.B.A.) degree and a graduate public administration degree in five years. This approach enables students to gain greater knowledge in specialized areas while completing fewer credit hours, with better scheduling flexibility than completing the two degrees separately.

Application to and acceptance into the M.P.A. program is open to students who have attained at least junior standing in the B.S. program. Students must maintain a combined 3.0 GPA to be admitted to and remain in a co-terminal degree program.

The application for the B.S./M.P.A. co-terminal program is accessible through the MyIIT portal (my.iit.edu). Under the Academics tab, locate the Undergraduate Academic Affairs channel and then access the link for the co-terminal application.

Other Co-Terminal Programs

- Bachelor of Science in Business Administration/Master of Science in Finance
- Bachelor of Science in Business Administration/Master of Science in Marketing Analytics
- Bachelor of Science in Engineering Management/Master of Public Administration
- Bachelor of Science in Social and Economic Development/Master of Public Administration

Graduate Certificate Programs

- Business Analyst
- Compliance and Pollution Prevention
- Corporate Finance (p. 452)[1]
- Economic Development and Social Entrepreneurship (p. 452)
- Entrepreneurial Finance (p. 452)[1]
- Financial Economics (p. 453)[1]
- Financial Modeling (p. 453)[1]
- Financial Toolbox (p. 453)
- Fundamentals of Finance (p. 453)
- Innovation and Emerging Enterprises
- Investments (p. 453)[1]
- Marketing Management
- Nonprofit and Mission-Driven Management (p. 454)
- Public Management (p. 454)
- Risk Management (p. 455)[1]
- Security, Safety, and Risk Management (p. 455)
- Sustainable Enterprise
- Trading (p. 455)[1]

1 Post-graduate

Course Descriptions

BUS 510
Building an Innovative and Sustainable Business
This is an introductory course on the fundamentals of doing business in an increasingly interconnected and hypercompetitive world where rapid information flows, environmental degradation, and societal challenges (e.g., poverty and ethics) can be viewed as both threats and opportunities facing for-profit enterprises. Students will learn that sustainable businesses are also innovative businesses and that sustainability often drives innovation. Students will not only be exposed to the basics of starting, growing, and running a profitable business but also learn how to do so in an environmentally and socially sustainable fashion. They will learn how companies create and capture value and how to analyze the business environment, industry, competitors, and customers. They will be introduced to corporate, business, and functional strategy and learn about different business functions (accounting, finance, operations, marketing, and information management). Students will be introduced to critical challenges of global sustainability and will explore through case studies how leading companies are implementing triple bottom line accounting, sustainable growth, and stakeholder value creation strategies. Finally, they will develop an innovative business idea to start a brand new company that has sustainable growth in its mission statement.
Lecture: 3 **Lab:** 0 **Credits:** 3

BUS 550
Business Analytics for Competitive Advantage
This course covers statistics, optimization, and simulation tools that are critical for managers in enabling their firms to have a competitive advantage. The course covers probability, sampling, estimation, hypothesis testing, linear regression, goodness-of-fit tests, linear optimization models, nonlinear optimization models, and managerial decision-making under uncertainty. The models address problems in finance, marketing, and operations and include applications such as media selection, capital budgeting, portfolio selection, advertising effectiveness, facility location, distribution planning, and production planning. The focus of the course is on using business analytics to build models and using software to aid in decision-making.
Lecture: 3 **Lab:** 0 **Credits:** 3

BUS 590
Business Innovation in the Next Economy
This is a forward-looking and experiential course that helps students understand how companies could successfully compete in the "next economy" through innovation and integrative problem-solving. It aims to integrate all of the key lessons from the M. B. A., M. S. EMS, and M. S. MAC programs to develop innovative solutions to solve real-world problems that actual companies face. The course is heavily project-based. Cross-disciplinary teams of students will act as management consultants to companies to identify and solve problems taking a holistic and integrative perspective. There will be lectures on various aspects of business strategy, sustainability, systems thinking, execution, innovation, and team effectiveness from faculty members and industry experts. Student teams will present their findings to fellow students, faculty members, and client companies. Prerequisite: Students should have successfully completed all of their respective program core courses.
Prerequisite(s): [(MBA 505, MBA 509, and MBA 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

BUS 598
Graduate Workplace Immersion
This course provides graduate students with a supervised, immersive, hands-on experience in a US workplace where they will gain exposure to an industry and practical experience with projects related to their interests. Students will work for a minimum of eight weeks, 32 hours/week. Students will be matched with an organization according to their area of study, related experience, and/or relevant skillset.
Lecture: 0 **Lab:** 0 **Credits:** 3

MAX 501
Insights into the Next Economy Markets
This course analyzes competitors, industries, and customers in the emerging global business environment. Understanding the demographics and psychographics of target audiences is essential to an effective marketing communication strategy. From data to information to insightful strategic marketing, this course covers what's important to know to make more effective marketing decisions. Social, cultural, psychological, and attitudinal factors are explored with particular attention to motivation, how attitudes are shaped and altered, how information is processed, and the role of learning in the formation of purchasing decisions. Theories and models of consumer behavior are examined to develop incisive insight into consumer behavior that can build strong brands. In addition to customer behavior, the course also covers tools and techniques to identify and analyze competitors and their strengths and weaknesses. Students will also learn a framework to analyze the relative attractiveness of industries and the techniques to analyze the threats and opportunities in the macro environment.
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 502
Analytics for Decision Making
Spreadsheets are a popular model-building environment for managers. Add-ins and enhancements to Excel have made powerful decision-making tools available to the manager. This course covers how to use the spreadsheet to develop and utilize some of these decision-making aids. Visual Basic for Excel allows the nonprogrammer to create modules for functions, subroutines, and procedures. Topics include forecasting (both regression and time series), decision-making under uncertainty and decision trees, using SOLVER for optimization, and probabilistic simulation using @RISK.
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 503
Marketing Research & Engg
The course is roughly divided into thirds which track the standard market research process: define the problem and design a research plan; develop appropriate primary research tools (primarily survey design and implementation); and execute an analysis and presentation. Marketing engineering focuses on specific data-driven marketing tools, regression, cluster analysis, conjoint, etc., and their application to specific marketing problems (segmentation and targeting, new product design, and forecasting). The market research process will be taught backwards from analysis to data acquisition with the aim that students will have a working understanding of their analytical goals by the time they begin their projects and can therefore establish sensible research objectives with an eye to expected use for the data.
Prerequisite(s): [(MAX 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 504
Creating, Communicating, and Delivering Customer Value
This course provides an introduction to the practice and strategy of marketing. Marketing activities are those processes and functions that enable managers and policy-makers to identify and serve the values and needs of a customer given the capacities of the company, activities of competitors, and inherent constraints in the business environment. Marketers typically refer to these concepts as the "four C's." Based on their understanding of the "four C's," students will then learn how to implement strategy by applying the levers of the marketing mix. These elements are known as the four P's (product, price, place/channels of distribution, and promotion). The treatment of marketing constraints and marketing mix will be motivated by essential foundations from economics, sociology, and consumer behavior. Over the course of the semester, students are expected to transition from thinking about these concepts in isolation to a dynamic, integrative framework. This process includes using the marketing strategy framework to assess business and policy problems from a "multiple objective" perspective: that is, the student will be asked to think about how marketing activities along with those of competitors and collaborators will affect the profitability, sustainability, social, and ethical standing of the firm. The synthesis of these concepts will be carried out through the use of case studies, problem sets, classroom lectures, discussions, and a field project. There will also be a midterm and final exam. The pedagogical style of the course emphasizes the students' role in applying the concepts discussed in the lectures to the situations at hand. The role of the instructor is to provide tools to structure thinking and to stimulate and facilitate analysis of the cases.
Prerequisite(s): [(BUS 510 and MAX 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 505
Strategic Marketing Management
In this course, we will emphasize both marketing strategy formulation and execution and the management of the marketing function. This includes the integration of marketing mix decisions, the longer-term effects of marketing mix decisions, and changes in the mix over time. For example: "Price" becomes "Price Policy", value-in-use, and price discrimination; "Product" becomes product line breadth and variety and product life cycle choices; "Place" becomes the design and control of single or multiple channels of distribution; and "Promotion" becomes communications, customer loyalty, and brand equity. The course will emphasize segmentation of the market, positioning the marketing mix to meet the needs of the market segment, sustaining an 'integrated' marketing mix over the product life cycle, and organizing the 'Strategic Business Unit' to implement the strategy. In addition to the development of a marketing strategy that 'positions' the product/service to the needs of one or more target markets (segmentation), the execution of a marketing strategy will require a marketing plan that includes the economic and financial analysis of the costs and potential profits of the strategy and an implementation plan including an organizational structure. This will often be an iterative process to find an optimal combination of costs and pricing and volume to maximize profits. This course will use readings, simulations, and cases for about half its content. The other half of the course will be a team consulting project for an external client.
Prerequisite(s): [(MAX 504)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 506
Fundamentals of Database Management Systems
This course covers the fundamentals of relational databases including its design and provides an in-depth coverage of SQL which is the de-facto language used to manipulate relational databases. This course places emphasis on understanding the concepts and principles of both relational database design and SQL in a platform/software neutral manner which equip students to work with most database systems used in the modern workplace.
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 511
Integrated Marketing Communication Strategy
In this course, students learn how to identify and evaluate the full gamut of competitive strategic alternatives in both business-to-business and business-to-consumer marketing using a wide variety of analytic tools to develop and analyze consumer insights. Based on this analysis, the major elements of a communication plan are put in place: media, message, target audiences, testable objectives, and budgets. Students learn to measure consumer and business target audiences by their demographic, psychographic, and attitudinal characteristics and to analyze the style and appeal of messages within campaigns. Students also learn how to develop a balanced marketing communication plan utilizing the multitude of vehicles available to reach a target audience using the latest technological tools and media.
Prerequisite(s): [(MAX 504)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 512
Customer Touch Points
This course focuses the massive transformations based on new technologies that are occurring in today's communication environment and the wide variety of consumer contact points it generates. Students will develop an understanding of how the industry is organized and how marketing communications flow from the source company to the target audience. The course examines the major aspects of developing and evaluating media plans beginning with the development of media strategies that flow from overall marketing communication goals. The course analyzes various media from the perspectives of cost, targeting, audience characteristics, and the nature of product/service.
Prerequisite(s): [(MAX 512)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 513
Managing Sustainable Brands
This is a traditional brand management course applied to green or sustainable brands which are becoming more and more important in the global economy. The most valuable assets that a company has are the brands that it has developed and invested over time. Students will explore the components of a brand, its equity, and emotional benefits and gain an understanding of how to develop a meaningful brand relationship with the customer or prospect to optimize the brand or brand portfolio. The class will also explore the various aspects required to champion a new product or service from development to launch by optimizing the execution through all the marketing efforts of the firm. Students will address positioning, channel strategies, trade promotion, budgeting as a part of the planning process, new product development, packaging and merchandising, and the management of agency relationships. Like people, brands have unique personalities that differentiate them and drive their ability to grow or limit their ability to expand.
Prerequisite(s): [(MAX 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 514
Customer Relationship Management
In a world where it costs five times as much to acquire a new customer as it does to keep an existing relationship, companies are learning that they must manage those current customer relationships in order to survive. Around this insight, a new discipline has emerged, using some of the tools of database management and some of the new tactics of digital communication to reduce attrition and to maximize the lifetime value of a customer. Customer relationship management (CRM) is making fundamental changes in the way companies operate. It is a critical point of merger where e-business becomes a part of all business. This course will engage the student in the diagnosis of CRM issues, the building of CRM plans, the measurement of their effectiveness, and the new tools available to get all these things done economically in internet time.
Prerequisite(s): [(BUS 550)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 515
Database and Direct Marketing
This course introduces students to the critical nature of information gathered in real time directly from important constituencies of third party sources. It explores the ability of data-based marketing to match consumers with products based on behaviors. Students learn to access and analyze database information as well as develop programs to elicit a direct and immediate response using a variety of direct-to-consumer/direct-to-business tools including electronic marketing.
Prerequisite(s): [(MAX 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 516
Social Media Mktg Strategy
The area of online marketing continues to develop at a rapid pace. Social media (including tools like Facebook, Twitter, LinkedIn, blogs, websites, e-mail, etc.) is no longer a passing fad but an essential component of the marketing mix. As the platforms evolve and expand, so do the strategies required to leverage them properly. The increased demand for this specialized knowledge creates abundant opportunities for career development, heightened visibility, and market leadership. Companies that fail to capitalize on social media to attract quality people, penetrate new markets, and engage with customers on a meaningful level will most certainly be left out in the cold. This class will explore the core strategies used by companies today to leverage the marketing power of social media to grow their businesses. Students will learn what makes each platform unique and how they contribute to an overall social media campaign.
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 521
Qualitative and Survey Research Methods in Business
This is an introductory course in qualitative and survey methods relevant to basic and applied research problems in businesses (with a focus on marketing). Although this is an introductory course, students should be prepared to engage seriously in how qualitative research is conceived, conducted, implemented, and interpreted in business contexts. The course does not emphasize statistical methods, and ability to quickly acquire working knowledge of basic statistics is assumed. The instructor will make an effort to work with students to cover essentials. Students will also require a good understanding of substantive business contexts. In short, while the course accomplishes several objectives, it will focus on the skills required to design and conduct research studies using qualitative and/or survey methods.
Prerequisite(s): [(BUS 550)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 522
Predictive Analytics
The digital enterprise captures significantly more data about its customers, suppliers, and partners. The challenge, however, is to transform this vast data repository into actionable business intelligence. Both the structure and content of information from databases and data warehouses will be studied. Basic skills for designing and retrieving information from a database (e.g., MS Access) will be mastered. Data mining and predictive analytics can provide valuable business insights. A leading data mining tool, e.g., IBM/SPSS Modeler, will be used to investigate hypotheses and discover patterns in enterprise data repositories. Analysis tools include decision trees, neural networks, market basket analysis, time series, and discriminant analysis. Both data cleaning and analyses will be discussed and applied to sample data. Applications of data mining in a variety of industries will be discussed. Software exercises, case studies, and a major project will prepare the students to use these tools effectively during their careers.
Prerequisite(s): [(BUS 550)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 523
Social Media Marketing Analytics
The pervasive adoption of internet technology has created an enormous opportunity to capture and analyze digital content exchanges from social media within and external to organizations. These analyses can provide valuable insights for improving the following: sales; customer service and loyalty; product quality, branding and development; employee satisfaction; and supply chain partner effectiveness. Data mining methods and analyses for websites, search engine results, and social media, e.g., Twitter, Facebook, and blogs, will be addressed. Text mining, GIS, speech analytics, and sentiment analyses will be studied. Both desktop and mobile device tools will be used to conduct these analyses.
Prerequisite(s): [(BUS 550)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 524
Advanced Predictive Analytics
This continuation of MAX 522 Predictive Analytics addresses complex data preparation methods and working with an enterprise data base system, e.g., DB2. More advanced variations of models from MAX 522 will be addressed, e.g., neural networks and cluster analysis. New models will be studied, e.g., Bayesian, Support Vector Analysis, and Time Series. Further big data analysis will be included, e.g., streaming sensor data. Web, audio, and video mining applications will be reviewed. More sophisticated visual analytics will be studied to improve the understanding of complex modeling results. A major project will provide a synthesis of the course learnings. Leading edge tools, e.g., IBM/SPSS Modeler, SAS Enterprise Miner, WATSON Analytics, IBM Streams, and Tableau will be used. These methods, models, and exercises will enhance significantly the mastery of predictive analytics.
Prerequisite(s): [(MAX 522)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 525
Cognitive Computing in Business
Our complex and dynamic world generates more data and potential information than the human mind alone can recognize, digest, analyze, and offer actionable insights. The IBM WATSON cognitive computing engine can offer significant intelligence amplification for individuals and their organizations to prosper in this challenging environment. This course will provide a complete journey from idea generation to completing a prototype application with WATSON. Student teams will identify a business opportunity, locate the relevant knowledge and load it into WATSON, prepare question-and-answer sets to train WATSON's ability to provide accurate responses to user queries, and develop friendly interfaces for user queries (natural language processing) and WATSON responses. After satisfactory training has been completed, a business and marketing plan for the application will be created. As new knowledge is fed into WATSON and new queries occur, WATSON's response performance will improve. Some experience with an object-oriented programming language is necessary to load knowledge, questions, and answers into WATSON. The commercialization of WATSON applications already has begun. This course provides the concepts, methods, skills, and experience to build a WATSON application that offers business value.
Prerequisite(s): [(MAX 522)]
Lecture: 2 **Lab:** 1 **Credits:** 3

MAX 526
Quantitative Models for Marketing
Over the past few decades, many quantitative models have been developed to analyze fundamental problems in marketing. This course will introduce a selection of important models which are used for marketing tasks such as demand modeling, elasticity analysis, price response analysis, and promotion planning. The underlying econometric theory of these models will be presented with emphasis on gaining hands-on experience in implementing and running these models on real marketing data. This course will provide a solid foundation to perform advanced marketing analytics.
Prerequisite(s): [(BUS 550)]
Lecture: 2 **Lab:** 1 **Credits:** 3

MAX 595
Special Topics in Marketing Analytics
This course covers contemporary or cutting edge topics in the marketing analytics field offered on an irregular basis typically in a seminar style. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MAX 597
Independent Study in Marketing Analytics
Students can conduct in-depth research, usually on an independent and solo basis, under the guidance of a full-time faculty member. Typically, a student signs up with a faculty member who is willing to supervise his/her independent research on a particular marketing analytics-related topic. The student has to complete the independent study form, develop a one-page proposal outlining the purpose, process, and product (expected outcomes) of the independent research project, and submit it to the program director and instructor for approval.
Lecture: 0 **Lab:** 0 **Credits:** 3

MBA 501
Accounting for Strategic Decision-Making
This course is an introduction to the basic financial and managerial accounting topics (GAAP, the major financial statements, accrual accounting, financial reporting alternatives, professional ethics, financial statement analysis, cost behavior, cost systems, short- and long-term decision-making with strategic considerations, and product costing) and a review of environmental accounting.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 502
Emerging Issues in the Global Business Environment
The course helps students understand the complexities of the globally-interconnected world of business they will be joining after graduation. It will set the background and context for their entire graduate business education. It will focus on emerging trends happening in six major components of the global business environment: political, economic, socio-cultural, technological, legal, and the natural environment. Special focus will be on ethical considerations in a cross-cultural setting. Students will be exposed to a mix of theories and managerial tools that will help them analyze the opportunities and threats within the global business environment and draw managerial insights.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 504
Analytics for Decision Making
This course has the following objectives: (a) to offer a comprehensive presentation of Microsoft Office Excel 2013; (b) to acquaint students with the proper procedures to create workbooks and worksheets suitable for coursework and professional purposes; (c) to enhance and reinforce students' analytical skills and their ability to intelligently use information; (d) to teach the art and science of spreadsheet modeling; (e) to expose students to different approaches, support tools, and analytical methods for decision making; and (f) to improve students' critical thinking skills.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 505
Contemporary Economic Analysis and Game Theory
This course applies economic principles to key decisions with organizations and solidifies intuition for understanding the business environments in which organizations operate. A key objective of the course is to develop tools useful in other Stuart courses. Economics is a key foundation for much of what is taught in finance, marketing, business strategy, environmental management, and virtually every other course in the graduate program. Economics is a way of thinking about problems, issues, and decisions that managers face in each of the functional areas of their organization. It stresses the importance of incentives in impacting human decision making and emphasizes the consideration of costs and benefits when making decisions. The course introduces and develops concepts in areas of microeconomics such as competition and market structure, incentive contracts, and pricing. Topics covered range from the most basic demand and supply models to principal-agent models and economics of information. The course will also touch on some of the primary macroeconomic topics (including GDP, inflation, and unemployment), topics in game theory (simultaneous and sequential games), and issues of ethics in economic policy-making pertaining to competitive and oligopolistic markets, pricing, and trade.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 506
Leadership in Knowledge-Intensive Organizations
To succeed in today's knowledge intensive organizations managers need to understand how individual differences in personality, learning style and cultural values, group dynamics, organizational culture, and human resource management policies shape employee attitudes and behaviors. This course teaches managers creative problem-solving and ethical decision-making, change management, leadership techniques for enhancing social capital and influencing other organizational members, and management tools for multicultural and geographically dispersed teams. Students will relate management concepts and techniques to real-world situations through the extensive use of case studies and experiential exercises.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 509
Financial Management in a Globalized World
In this course, the student will learn the concepts and processes that underlie enlightened financial decision making in a global world. Students will explore how to raise debt and equity capital, how to think about what portion of earnings to retain and reinvest and whether to share some earnings with stockholders via dividend payments or repurchase of shares, how to value stocks and bonds, how to distinguish good from bad financial decision rules, how to decide which projects a firm should engage in, how to use futures, options and swaps to manage firm risk, how to ensure good corporate governance, why sustainability can be profitable while still protecting future generations, and how to manage the financial decisions required to effectively operate in a global setting.
Prerequisite(s): [(BUS 510 and MBA 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 511
Creating, Communicating, and Delivering Customer Value
This course provides an introduction to the practice and strategy of marketing. Marketing activities are those processes and functions that enable managers and policy-makers to identify and serve the values and needs of a customer given the capacities of the company, activities of competitors, and inherent constraints in the business environment. Marketers typically refer to these concepts as the "four C's." Based on their understanding of the "four C's," students will then learn how to implement strategy by applying the levers of the marketing mix. These elements are known as the four P's (product, price, place/channels of distribution, and promotion). The treatment of marketing constraints and marketing mix will be motivated by essential foundations from economics, sociology, and consumer behavior. Over the course of the semester, students are expected to transition from thinking about these concepts in isolation to a dynamic, integrative framework. This process includes using the marketing strategy framework to assess business and policy problems from a "multiple objective" perspective: that is, the student will be asked to think about how marketing activities along with those of competitors and collaborators will affect the profitability, sustainability, social, and ethical standing of the firm. The synthesis of these concepts will be carried out through the use of case studies, problem sets, classroom lectures, discussions, and a field project. There will also be a midterm and final exam. The pedagogical style of the course emphasizes the students' role in applying the concepts discussed in the lectures to the situations at hand. The role of the instructor is to provide tools to structure thinking and to stimulate and facilitate analysis of the cases.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 513
Operations and Technology Management
The course seeks to help the student develop an understanding of the concepts and skills needed for the design and control of operations in both services and manufacturing organizations. Students will take a strategic and general management approach to the design of an operating system and its supporting organizational structure and infrastructure including information systems, human resource management, and financial policies. The focus is on the strategic role of operations and technology decisions as a source of competitive advantage for the firm with an emphasis on the integration of R & D/Design/Engineering, operations and marketing within the context of the business unit's strategy, and the organizational structure and skills needed to execute and manage the operating system. The overal goal is to create, achieve, and sustain operational effectiveness. The course will emphasize the analytical tools and techniques that are useful in making decisions about projection facilities and capacity, choices of technology and equipment, task and process design, organizational architecture, human resources policies, and the physical and managerial control of operations. Students will gain an understanding of the economics of operations including trade-offs between fixed and variable costs, marginal/incremental analysis to identify relevant versus sunk costs, optimization, and productivity measurements for both capital and labor. Case studies will provide opportunities for students to develop their skills in process design and choice, process mapping, critical thinking, identification of problems versus symptoms, process improvement, and capacity measurement in the context of the business strategy while the simulations will provide an opportunity to practice the management of a particular operating system. Students will also gain an understanding of how human behavior and organizational design, along with quantitative optimization, forms the theoretical underpinning of operations management.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 518
Ethics & Corporate Social Responsibility
The corporate scandals and implosions of the past decade, climaxing in the global financial crisis of 2008, have highlighted how critical ethical and socially-responsible decision-making and leadership are to the long-term survival and success of both individual businesses and society. This course will endeavor to teach students why ethics and corporate social responsibility are not just feel-good exercises but are essential for business success in the Next Economy.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 522
The General Manager
This course is about general management, general managers, and the challenges of creating and sustaining competitive advantage by maintaining the fit between industry competitive structure, strategy, organization structure, tactics, and activities (execution) at both the corporate and the business unit levels. Students will be concerned with both the problem of choosing what businesses the firm wants to engage in (the portfolio and diversification of risks) and the task of maximizing profits in the specific businesses the corporation has chosen to enter. In some of the case discussions and the CAPSIM game, students will take the choice of business as a given and focus on how to create a strategy and the network of activities or value chain that implements/executes the strategy of the strategic business unit (SBU), taking into account the interactions and trade-offs among marketing, production, finance, engineering, and human resources decisions as the industry structure changes over time and in the context of active competitors. Students will also be looking at the corporate level choices of entering, growing, or exiting various businesses/markets, the tactics/activities used to execute corporate strategy, the organization structure issues of very large multi-business firms, and the relationships among SBUs and between corporate headquarters and the strategic business units. Completion of program core or instructor permission is required.
Prerequisite(s): [(BUS 510, MBA 505, and MBA 509)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 523
Negotiations and Strategic Decision Making
This course is designed to foster an understanding of incentives and strategic decision-making as they apply to negotiations. The course has both theoretical and applied components with the objective of addressing both theory and skills as they apply to dyadic and multiparty negotiations, to buyer-seller transactions, to competitors' interactions, to the resolution of disputes, and to the development of negotiation strategies. The theoretical component is focused on an analytical study of strategic interactions using game theory while the applied component is based on a series of simulated negotiations in a variety of contexts including one-on-one, multiparty, and team negotiations. The objectives of the course are to provide an analytical foundation, to show where practice and theory diverge, and to provide a forum where negotiation tools in a variety of business-oriented settings can be actively applied. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 524
Leadership in Multicultural Organizations
Managerial leadership is one of the primary drivers of an organization's success. Not surprisingly, organizations are demanding effective leadership skills from managers at all levels. This course is designed to enhance students' understanding of leadership in contemporary organizations. Students will develop a conceptual framework of effective leadership in multinational organizations. Besides discussing leadership skills and traits, particular attention will be devoted to exploring the influence of organizational and societal context on leadership. This course will be taught with an experiential learning approach. Through self-assessments, case analyses, and a variety of other exercises, students will augment their leadership skills.
Prerequisite(s): [(MBA 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 526
Sustainable Supply Chain Management
We will present models and practices that minimize supply-demand mismatch and therefore maximize companies' own profitability as well as models and practices of collaboration with other companies in a supply chain that minimize risk and environmental costs and therefore maximize the supply chain's sustainability. This course will have an emphasis on the integration of business and technology aspects. We will first introduce an integrated view of the production and logistics functions in organizations such as capacity analysis, inventory management, and logistics management. The course then discusses topics involved in the interaction of a firm with others players in a supply chain such as valve of information, supply contracts, and risk sharing. Finally, the course will introduce models/tools enabling sustainability actions plans, for example, reducing waste in the supply chain, both upstream and downstream.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 528
Healthcare Management, Technology, and Innovation
Healthcare is one of the most fundamental human problems around the world. Besides food and water, every one of the seven billion people on earth needs healthcare. Yet, the current systems of healthcare delivery have inadequacies in providing quality care to all. In this respect, technological innovations have begun to contribute creative solutions to the many problems that healthcare delivery systems face with access to care, affordability of care, and consistent quality of care. This course focuses on how the management of technology and innovation and business and strategy principles can converge to understand the trends, problems, and potential solutions to the American healthcare delivery system and to other systems around the world. The course aims to acquaint the student with the issues and potential solutions of managing the healthcare delivery system. The healthcare sector has unique characteristics as both a social and business enterprise where private and public organizations and enormous resources are involved. The student will gain knowledge about the structure of the healthcare delivery system and how technology and innovation are contributing to some solutions to its most pressing problems of access, affordability, and quality of care. The student will also gain knowledge about the key technology dimensions and forces that shape the industry.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 529
Social Entrepreneurship
This course gives students a practical introduction to the exciting and rapidly growing field of social entrepreneurship. The course will begin by introducing students to contemporary understandings of poverty, its causes, and traditional poverty alleviation strategies. It will then turn to key concepts regarding social ventures including entrepreneurship, organizational structures (for-profit, non-profit, and hybrid), financing, marketing, and performance assessment (social and environmental impact). We will also examine the challenges that are faced in creating and operating social enterprises in different parts of the world. The course includes guest lectures by other Stuart School of Business faculty and social entrepreneurs working in different areas (such as health, education and environment). Students will gain hands-on experience by either developing a business plan for a social enterprise to address a specific real world problem or assisting an existing social venture in developing a business plan geared towards an expansion of its services. It is expected that the plans can be entered into a variety of social venture competitions.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 554
Project Management
This course addresses both analytical and behavioral skills for effective project management. You will learn how to select a project portfolio, develop a work breakdown structure, estimate task times and costs, allocate and level resources, prepare Critical Path and PERT analyses, and assess earned value project performance. A leading project management tool, e.g. MS Project, will be used for project management exercises. Much of the course content will be drawn from the Project Management Institute common body of knowledge and certification program. Management of project risks, structure, team building, and conflict will be addressed. A project management simulation game provides an opportunity to apply your team-based skills. A variety of project management cases across industries will be studied.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 564
Competing in Emerging Markets
For Western MNCs, some of the most intriguing growth opportunities in the Next Economy exist in low-income segments, the so-called markets at the bottom of the income pyramid, in emerging and underdeveloped countries of the world. Historically, MNCs targeted the customers at the top of the pyramid in these countries because their business models worked well for them. But as these bottom-of-the-pyramid markets become more economically profitable, MNCs need to make a serious attempt to evaluate and target them. In order to successfully compete for customers in these markets, MNCs should design innovative business models that could represent a radical departure from the way they do business in more advanced countries. This course is about such business model innovation. Students will learn tools of international market opportunity analysis, foreign market entry strategies, the social, economical, and ethical factors affecting decisions to serve low income customers, the stringent requirements of the customers at the bottom of the pyramid, and business models to profitably serve these customers.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 566
Understanding China: History, Politics and Economics
While the 21st century may or may not be called the Chinese century, there is no doubt that China has become a dominant political, economic, and business force on the global stage. The fastest and the largest markets for many products and services are located in China. The supply chains for most manufacturing industries pass through China. Increasingly, China is becoming the base for high value-added activities, such as research and development. The center of economic gravity is shifting to China, and every aspiring business executive needs to understand China and how to do business with it. In this course, students learn about China's history, politics, and economics. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 567
Chinese Language and Culture
The course provides non-Chinese business people an understanding of the Chinese language, culture, ethnic diversity, and traditions. Understanding culture is an essential first step to understanding business practices and customs. So the ultimate objective of this course is to help non-Chinese business people understand how to effectively deal with Chinese customers, suppliers, and business partners.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 569
Competitiveness of Asian & Western Enterprises
This course helps students understand the economic context within which Asian enterprises and Western enterprises evolved and how they tend to compete on very different factors. While many business principles are universal, the key drivers of competitiveness differ substantially between Asian and Western enterprises. More importantly, within these groups there could be significant nationality-based differences. The course provides an insightful comparative study of companies based in opposite ends of the world and helps students understand why they employ different sets of strategies to compete and succeed on the global stage. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 570
Business Study Mission to China
China has become a major business destination for companies around the world. The success of managers and entrepreneurs around the world today may depend on how well they do business with Chinese customers, suppliers, and partners. One of the best ways to understand this is through immersion. This course involves a business study mission trip to some of the epicenters of Chinese business, such as Shanghai. Students will be able to visit foreign and local manufacturing and service companies located in China, listen to business leaders and government officials, and enjoy the cultural immersion experiences. Students will attend several briefing sessions prior to the visit and a debriefing session following the visit. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 575
Creativity and Contemporary Entrepreneurial Opportunities
Entrepreneurship focuses on the concepts, skills, know-how, information, attitudes, and alternatives that are relevant for start-up and early-stage entrepreneurs, entrepreneurial managers, and the relevant stakeholders. Specifically, this course provides an introductory overview of the knowledge and skills needed for the identification, evaluation, and exploitation of opportunities in a variety of circumstances and environments. It concentrates on the study of various innovative thinking in strategy, identifying and screening a business opportunity, developing business models, preparing business plans, securing financing, and managing high-growth firms. It integrates knowledge gained from the prior core business courses (i.e., management, marketing, finance, and accounting) to sharpen the student's ability to think strategically, innovatively, and entrepreneurially and to form new ventures. Further, it is a course that mixes theory with practices covering industries such as computer, cell phone, biotech, and wireless, to name just a few. Students will be challenged to apply principles, concepts, and frameworks to real world situations, culminating in a formal business plan.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 576
Creating and Financing New Technology Ventures
The course concentrates on the study of entrepreneurship, preparation of business plans, methods for evaluating and screening new venture ideas, formulation and implementation of business strategies for new ventures, development of a business plan, the financing of new ventures, and venture growth strategies and exits. It integrates knowledge gained from the prior core business courses (i. e., management, marketing, finance, and accounting) to sharpen the student's ability to think entrepreneurially and form new ventures. The course will also focus on identifying, examining, and evaluating various sources of original and growth capital. Emphasis will be on legal, financial, and tax issues related to capital formation as well as specific problems experienced by the small-to-medium-sized firm undergoing rapid growth in the high technology space. Topics discussed will include venture valuation, financing startups, financial planning and strategy, going public, selling out, and bankruptcy. A formal proposal for capital acquisition developed through field research will be required of each student.
Prerequisite(s): [(BUS 510)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 577
Got Creativity?: Strategies and Tools for the Next Economy
This class will look at creativity from three broad perspectives: personal creativity (how to think about this as a personal skill to be enhanced and trained); organizational creativity (why it is job #1 for EVERY organization and how we can systematically enhance the innovation outputs of the enterprises we work for); and civic creativity (how to lift creativity and innovation into sustainable policies for our cities and regions). We will mix presentations with performances. We will have experts visit the class. We will get up on their feet and do small group work and creativity exercises. We will visit creativity hot spots around Chicago and learn first-hand from our leaders on how to make environments that nourish innovation. We will learn about and work on 13 distinct personal creativity competencies. Finally, we will work in teams on special projects and present.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 581
Marketing Research and Engineering
The course is roughly divided into thirds which track the standard market research process: define the problem and design a research plan; develop appropriate primary research tools (primarily survey design and implementation); and analysis and presentation. Marketing engineering focuses on specific data driven marketing tools, regression, cluster analysis, conjoint, etc., and their application to specific marketing problems (segmentation and targeting, new product design, and forecasting). The market research process will be taught backwards from analysis to data acquisition with the aim that students will have a working understanding of their analytical goals by the time they begin their projects and can therefore establish sensible research objectives with an eye to expected use for the data.
Prerequisite(s): [(MBA 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 586
Strategic Marketing Management
In this course we will emphasize both marketing strategy formulation and execution and the management of the marketing function. This includes the integration of marketing mix decisions, the longer-term effects of marketing mix decisions, and changes in the mix over time. For example: "Price" becomes price policy, value-in-use, and price discrimination; "Product" becomes product line breadth and variety and product life cycle choices; "Place" becomes the design and control of single or multiple channels of distribution; and "Promotion" becomes communications, customer loyalty, and brand equity. The course will emphasize segmentation of the market, positioning the marketing mix to meet the needs of the market segment, sustaining an integrated marketing mix over the product life cycle, and organizing the strategic business unit to implement the strategy. In addition to the development of a marketing stategy that positions the product/service to the needs of one or more target markets (segmentation), the execution of a marketing strategy will require a marketing plan that includes the economic and financial analysis of the costs and potential profits of the strategy and an implementation plan, including an organizational structure. This will often be an iterative process to find an optimal combination of costs, pricing, and volume to maximize profits. This course will use readings, simulations, and cases for about half its content. The other half of the course will be a team consulting project for an external client.
Prerequisite(s): [(MBA 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 587
Nonprofits and the Public Sector
Provides an overview of the complex and important relationship between government and non-profits. This course includes a review of the history, funding schemes, the differences between grant and contract funding, recent trends, and much more.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 588
The Nonprofit Sector
Considers the role played by the nonprofit sector in the larger American society and economy. Topics include major organizational forms, financial management, human resource policies, leadership, board-executive relations, and private-public connections.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 589
Regulatory Politics and Contemporary Business
Regulatory activity remains government's major point of interaction with both business and citizens. Government regulation affects a myriad of activities and is the primary function of public administration. Regulation is a key variable of American economic activity, an issue of global concern, and an expanding field of modern jurisprudence. This course is intended to provide an understanding of regulatory activity as influenced by changing social, technological, and economic conditions within a context of dynamic political culture. It will familiarize students with a range of concepts concerning the role of positive government and the growth of the American administrative state. The course will present regulation as a process and examine the role of government, business, and citizen interest group in regulatory development. It will present various types of regulatory activity and review federal, state, and local regulatory networks and responsibilities. The course will also examine the evolution of constitutional interpretation and the subsequent adaptations of American law to facilitate changing and regulatory actions.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 595
Special Topics: MBA Program
Special topics in business administration.
Lecture: 3 **Lab:** 0 **Credits:** 3

MBA 597
Independent Study in Business Administration
Independent study in business administration.
Credit: Variable

MSC 511
Economics I
This is the first of a two-semester sequence in advanced-level economics. It offers a rigorous treatment of modern microeconomics theory which includes consumer theory, theory of the firm, decision making under uncertainty, and game theory. The course examines various market settings such as competitive markets, oligopolies, and monopolies. Other topics considered include consumer preferences and production functions, choice under uncertainty, various measures of welfare and efficiency, equilibrium concepts, public goods, externalities, mechanism design, adverse selection, and moral hazard. Focus is on major topics of economic analysis and the tools used to study them. Some mathematics background, particularly calculus, is essential.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 512
Statistics I
This course provides a comprehensive introduction to the statistical approach of tackling research problems (random variables; transformations; popular distributions used in management science such as normal, Student T, Chi-square, and generalized lambda; sampling methods, parameter estimation, confidence intervals and joint confidence intervals; hypotheses testing, sample size and power, regression and correlation), and statistical modeling. It will focus on the mathematics of differential equations, stationary time series models, conditional heteroscedasticity, non-stationary time series, cointegration and non-linear models. Students will also learn techniques like maximum likelihood estimation, likelihood ratio tests, and generalized method of moments estimation. Students will be introduced to stochastic processes and applied probability, Bayesian statistics, computational inference, extreme value theory, survival analysis, design of control and cohort experimental studies, introduction to SAS statistical software, issues in data-screening/diagnostic testing, model specification and estimation issues and empirical analyses involving large databases.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 513
Optimization I
This course introduces optimization techniques with a focus on linear and integer optimization problems. Topics include: the simplex method and its variants, interior point algorithms, duality and sensitivity analysis, integer linear programming, cutting plane method, branch and bound method, Lagrangian relaxation methods, model formulation with integer variables, large scale optimization, and network flow problems.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 514
Economics II
This is the second course in the two course economics core sequence. It provides a basic introduction to game theory and explores its use in modern economics and business through examinations of classic and current papers. It covers the nature and existence of equilibrium in static and dynamic games, repeated games, and implications of asymmetric information including signaling, adverse selection and moral hazard and there application to modern business problems in finance, operation research and marketing. it also introduces students to models used in modern macroeconomics.
Prerequisite(s): [(MSC 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 515
Statistics II
The course begins with the classical linear regression model and variations based upon non-linearity, non-normality, heteroscedasticity and autocorrelation. Limited dependent variable model will be introduced as well. The course includes a discussion of cross-section data, systems of regression equations, and panel data estimation. This course intends to integrate modern theories and empirical applications in a manner that many useful tools will be discussed to facilitate Ph.D. students' dissertation work. The course is heavily project oriented, and students will be expected to work with modern statistical packages such as Stata and with large datasets.
Prerequisite(s): [(MSC 512)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 516
Optimization II
This course introduces dynamic programming and applications of dynamic programming to deterministic and stochastic decision problems. The course also introduces the theory and computation methods of nonlinear programming, convex analysis, and unconstrained methods; Kuhn-Tucker theory, saddle points and duality, quadratic linearly constrained and nonlinear constrained problems, and penalty and barrier methods.
Prerequisite(s): [(MSC 513)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 611
Philosophy of Management
This course introduces doctoral students to the history and evolution of thinking in the management discipline. It focuses attention on theories of leadership and innovation, and showcase contributions of influential thought leaders in management. It also includes epistemological perspectives with substantial potential for enhancing business research. Finally, it will address fundamental approaches and criteria for successful theory development.
Prerequisite(s): [(MSC 511, MSC 512, MSC 513, MSC 514, MSC 515, and MSC 516)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 612
Advanced Research Methods
This course is a required course for all PhD students at the Stuart School of Business. It offers a comprehensive overview of the General Linear Model at both univariate and multivariate research levels. The course will review measurement issues (reliability, types of validity), multiple regression analysis, ANOVA, MANOVA, step-down analysis, factor analysis, structural equation models (exploratory and confirmatory factor analysis), discriminant analysis, redundancy analysis, canonical correlation analysis, repeated measures analysis, categorical data analysis, contingent valuation method, conjoint analysis, cluster analysis, multidimensional scaling, correspondence analysis, choice models, and relatively new areas such as multi-level analysis, meta-analysis, data warehousing, data mining, and neural networks. Additionally, nonlinear models will also be discussed. Students will be introduced to SAS and other software packages.
Prerequisite(s): [(MSC 511, MSC 512, MSC 513, MSC 514, MSC 515, MSC 516, and MSC 611)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 621
Corporate Finance
The primary objective of this course is to provide doctoral students an overview of introductory topics in corporate finance including capital structure, agency theory, corporate governance, payout policy, compensation, mergers and acquisitions, diversification, equity issuance, private equity, and financial intermediation. We will focus on both theories and empirics of financial economics in the area of corporate finance. Students should expect a rigorous course with substantial academic rather than applied content, and expect an intensive reading list. Another objective is to train students to read, understand, and present background papers in corporate finance and recognize the interesting/important problems in corporate finance in the "right" institutional structure.
Prerequisite(s): [(MSC 511)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 622
Enterprise Risk Management
This course focuses on the two main silos of risk in the financial industry, namely, credit risk and operational risk. The course will also discuss asset and liability management, interest rate risk management, integration of credit risk and market risk, regulatory and compliance issues and performance measurement and capital management. The quantitative aspects of the course include: volatility and correlation modeling, Monte Carlo simulation, stress-testing scenarios analysis, and extreme and tail events modeling.
Prerequisite(s): [(MSC 512 and MSC 631)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 623
Investments
The world of investments is changing rapidly as investment responsibilities and power move into the hands of individuals. This course discuss the properties of investment instruments, different investment theories, and the professional investors. Topics include the characteristics of various financial assets, the time series and cross sectional of returns, asset pricing theory and empirical methods, mutual funds and hedge funds. Moreover, there is a reading list of the most influential academic papers in the investment field, students are required to understand and follow the most advanced development in the investment field.
Prerequisite(s): [(MSC 601)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 631
Theory of Finance I
This course is intended as an in depth review of the following areas of finance: (1) utility theory and expected utility valuation techniques; (2) the Markowitz portfolio problem and the CAPM model; (3) the APT theory and general linear arbitrage factor model; (4) single period consumption-based asset pricing models; (5) state preference theoretic approaches; (6) multi-period discrete time utility based models and associated mathematical techniques; (7) equilibrium and price bubbles in the preceding model (the "Lucas" model); (8) basic binomial derivative pricing; and (9) Ito's Lemma, Black-Scholes, and related models.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 632
International Finance Theory
International Finance Theory.
Prerequisite(s): [(MSC 605 and MSC 631)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 633
Theory of Finance II
This course is intended as an in depth review of the following areas of finance: (1) continuous time risk neutral pricing; (2) jump diffusion models; (3) continuous time utility optimization modeling (with dynamic programming); (4) consumption CAPM modeling; (5) non-time seperable utility modeling; and (6) behavioral finance.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 651
Quantitative Marketing Models
This seminar will acquaint students with quantitative models used in marketing research literature. It will survey a variety of econometric models ranging from basic choice models to the latest structural models which have been used to analyze problems in the marketing domain. In summary, the course will provide an overview of the quantitative modeling field in marketing. The emphasis will be on understanding the estimation procedure employed to estimate these models.
Prerequisite(s): [(MSC 511, MSC 512, MSC 513, MSC 514, MSC 515, and MSC 516)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 652
Supply Chain Analytics
This course focuses on modeling and analytical skills by introducing (1) an integrated view of the production and logistics functions in organizations by discussing models such as facility location, capacity allocation, warehousing, transportation, forecasting, inventory management, and risk-pooling models and (2) how firms interact with each other in a supply chain by discussing topics such as value of information, supply chain contracting and coordination, price-based and quantity-based revenue management. In addition to developing quantitative modeling skills, this course focuses on data analytics in the supply chain context and the interface of supply chain analytics and customer analytics. The course will help students (1) gain an understanding of various aspects, issues, and initiatives in contemporary supply chain practice and (2) develop their ability to conduct quantitative research in supply chain management using recent literature published in top tier journals.
Prerequisite(s): [(MSC 511, MSC 512, MSC 513, MSC 514, MSC 515, and MSC 516)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 653
Current Topics in Marketing Analytics
The focus of this course would be to stay up-to-date with cutting edge academic research in the field of marketing analytics. Students would read and discuss current literature that develops and applies methods for optimizing digital marketing communications, evaluating the impact of digital marketing strategies, and performing market research through the analysis of secondary social media data. Students would need to be reasonably well-versed in a variety of analytics approaches coming in and capable of learning new methods that appear in the literature through self-study. The emphasis would be on critical discussion of cutting-edge marketing analytics techniques and application, self-study of methods and current digital platforms to keep pace with trends and breakthroughs in the field, and research idea generation.
Prerequisite(s): [(MSC 511, MSC 512, MSC 513, MSC 514, MSC 515, and MSC 516)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 654
Social Network Analytics
This course focuses on the following: (1) analyzing social networks through statistical descriptors of networks (link analysis, centrality, and prestige), network clustering (modularity and community detection), dynamics of information and epidemics spreading (threshold and information cascade models), and network visualization algorithms (spring-like layouts, multidimensional scaling, Gephi). (2) applications of text and document analysis using natural language processing and part-of-speech tagging, sentiment analysis, and topic modeling. (3) assessing collective intelligence using recommender systems, collaborative filtering, and machine learning, in particular deep learning.
Prerequisite(s): [(MSC 511, MSC 512, MSC 513, MSC 514, MSC 515, and MSC 516)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSC 691
Research and Thesis PhD
Credit: Variable

MSF 501
Mathematics with Financial Applications
This course provides a systematic exposition of the primary mathematical methods used in financial economics. Mathematical concepts and methods include logarithmic and exponential functions, algebra, mean-variance analysis, summations, matrix algebra, differential and integral calculus, and optimization. The course will include a variety of financial applications including compound interest, present and future value, term structure of interest rates, asset pricing, expected return, risk and measures of risk aversion, capital asset pricing model (CAPM), portfolio optimization, expected utility, and consumption capital asset pricing (CCAPM).
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 502
Statistical Analysis in Financial Markets
This course presents and applies statistical and econometric techniques useful for the analysis of financial markets. Ordinary least squares, maximum likelihood, time series analysis, GARCH volatility modeling, and simulation methods are covered. Hypothesis testing is covered in detail. Particular attention is placed on the properties of various estimators when model assumptions do not hold. Students not familiar with matrix algebra and elementary statistics should plan to make up the deficit early in the course. See MSF 501 on these topics.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 503
Financial Modeling
Financial modeling in a spreadsheet environment is a pervasive feature of the modern workplace. In this course, students will learn how to implement financial models using spreadsheet modeling and basic programming via Microsoft Excel and VBA. Financial models will include project valuation, bond pricing and hedging, option pricing, and portfolio optimization. The course will also cover basic numerical techniques that are essential to financial modeling including Monte Carlo simulation and linear optimization.
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 504
Valuation and Portfolio Management
The course is a survey of asset pricing theory. The fundamentals of bond and option pricing are covered as well as the CAPM, APT, and the Fama-French models. Excel spreadsheet modeling is used to illustrate and understand the concepts of Markowitz's Mean Variance Optimization, equity valuation, option pricing, and utility theory. The course places a special emphasis on the relationship between macroeconomic conditions and investment opportunities.
Prerequisite(s): [(MSF 501, MSF 502, and MSF 503)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 505
Futures, Options, and OTC Derivatives
This course provides the foundation for understanding the price and risk management of derivative securities. The course starts with simple derivatives, e.g., forwards and futures, and develops the concept of arbitrage-free pricing and hedging. Based upon the work of Black, Scholes, and Merton, the course extends their pricing model through the use of lattices, Monte Carlo simulation methods, and more advanced strategies. Mathematical tools in stochastic processes are gradually introduced throughout the course. Particular emphasis is given to the pricing of interest rate derivatives, e.g., FRAs, swaps, bond options, caps, collars, and floors.
Prerequisite(s): [(MSF 501, MSF 502, and MSF 503)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 506
Financial Statement Analysis
After reviewing the content of the major financial statements, the course examines ratios, inventories, long-lived assets, income taxes, debt, leases, and pensions, among other topics. U.S. practices are compared to practices in other major countries. This course is intended for those who will examine financial statements of outside organizations.
Prerequisite(s): [(MSF 501, MSF 502, and MSF 503)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 524
Models for Derivatives
The practice of financial engineering requires skill in financial theory and practice, mathematics and programming. This course includes instruction in all of these areas. In this class, students will learn mathematical and computational methods that are applicable to the pricing and risk management of derivatives. The class provides an introduction to options pricing theory, covering stochastic calculus, the Black-Scholes partial differential equation, risk-neutral valuation and hedging portfolio replication. The course will focus on important numerical techniques used in finance, including variance reduction techniques in Monte Carlo Simulation and finite difference methods applied to partial differential equations. These methods will be applied to the pricing of exotic options. In this class, students will learn to program and implement financial models in Matlab.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 525
Term Structure Modeling and Interest Rate Derivatives
Upon completion of this course, students should know the strengths, weaknesses, appropriate uses, and ways of implementing the major term structure models that are in common use. The course will begin with bootstrapping of forward curves, principal component analysis, and a review of basic fixed income derivatives (swaps, swaptions, caps, and floors). We will then implement short rate models, such as Ho-Lee, Black-Derman and Toy, and extended Vasicek/Hull-White, followed by the Helath-Jarrow-Morton model and market rate models. Students will implement these term structure models in Excel/VBA and Matlab.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 526
Computational Finance
The use of computers makes modern finance possible. Most of the mathematics behind the risk management techniques and pricing models would be of no practical use without automated solvers, scenario builders, and other algorithms. This class concentrates on translating from ideas and mathematics to the practicalities of implementation. We will begin with a brief motivating discussion and then address various kinds of financially relevant algorithms, paying special attention to the two most important features of any scheme: (1) how it can go wrong and (2) how it can be calibrated. Our topic list will include optimizers, quadrature, fast fourier transforms, grid PDE solvers, and Monte Carlo techniques.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 534
Corporate Finance
This course is an advanced introduction to modern corporate finance. Topics include cash flow forecasting, optimal dividend policies, mergers and acquisitions, structured finance, capital at risk, and the risk of adjusted return on capital. The philosophical foundation of the course is the concept of shareholder value added. Students will learn how financial decisions can contribute to the value of a modern corporation.
Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 535
Investment Banking
This course covers the financing and formation process of private companies from product concept and angel investors to the Initial Public Offering. Exit strategies for private investments are discussed, including IPOs, mergers and acquisitions. Strategic and financial buyers play a key role in the valuation of a newly public or recently acquired firm. All of the players are discussed, including venture capitalists, entrepreneurs, investment bankers, attorneys, public shareholders, merger partners, institutional investors and private equity/buyout firms. Students will discuss business models; construct staffing and compensation schemes; practice valuation analysis; compare and contrast alternative financial sources; structure business plans; review the types of securities to offer; examine private placement processes; analyze negotiation strategies; and review the implications of financing terms and the role of venture capital and private equity investment in institutional portfolios. The challenges of completing mergers and integrating merged companies are also discussed. Sarbanes-Oxley, anti-trust requirements and other regulatory issues will be presented.
Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 543
Alternative Investments
Alternative investments include real estate, hedge funds, managed futures, and emerging markets. They are attractive to institutional investors because they exhibit a low correlation with traditional investments in stocks and bonds. However, they must be approached cautiously because of specific difficulties in valuing these assets. This course will explore a variety of alternative investments and their role in investment strategies.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 544
Equity Valuation
This course covers the various models available for equity valuation. It includes discussions of the dividend discount model, Porter analysis, DuPont decomposition of ROE, sustainable growth rates, earnings quality, and accounting fraud. It also covers relative valuation measures such as price/earnings and price/sales ratios. The valuation techniques taught in the course will be applied to the valuation of equity shares, corporate bonds, and derivatives such as stock options and convertible bonds. Completion of a comprehensive analysis of a public company is a requirement for the course. This course is recommended for students who are planning on sitting for Certified Financial Analyst (CFA) qualification.
Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 545
Structured Fixed Income Portfolios
This course will cover the characteristics, valuation and risk management of fixed income instruments. These instruments include bonds, repos, interest rate derivatives, inflation indexed securities, mortgage-backed and asset-backed securities, CDOs and default swaps. The focus will be on understanding how these instruments are structured and used. Term structure modeling and hedging techniques will be presented, with a minimum of mathematics.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 546
Quantitative Investment Strategies
This course develops the primary quantitative tools used in the portfolio selection process. The applied focus of the course centers on the process of moving from a data set of historical information to the formulation of a forecasting model, the estimation of mean-variance efficient portfolios, and the testing of efficiency hypotheses within an in-sample and post-sample setting. The course covers the estimation of efficient portfolios, factor models, forecasting models, and risk analysis.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 549
Commodities and Managed Futures
Commodity markets have experienced dramatic growth and increased institutional investment in recent years. This course explores cash and futures markets in energy, grains, metals and soft commodities, as well as equity investments in commodity related firms. Students will explore the role of hedgers, speculators and institutional investors in commodity markets. The value of commodities in the institutional portfolio will be presented, which may allow hedging against inflation and the risks of declining stock and bond prices. Commodity trading advisers, commodity pool operators and the managed futures industry will be discussed. These fund managers initiate both long and short positions in futures markets, typically constructing portfolios from either a systematic or discretionary perspective.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 554
Market Risk Management
This course introduces the importance of financial risk management by developing practical risk measurement tools. The risk measurement aspect of the course begins with the development of the Value-at-Risk (VaR) methodology for financial instruments traded in open markets including equities, bonds, foreign currencies and their derivatives. The course develops analytic VaR models for instruments with non-linear payoffs and non-normal distributions and it also develops simulation methodologies for risk analysis. Statistical tools in volatility forecasting, tail events, and expected shortfall are introduced as appropriate. The emphasis of the course is on market risk, but in addition to the traditional analysis of trading rooms, the course also considers regulatory and compliance risk, corporate risk and risk analysis for investment managers.
Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 555
Credit Risk Management
The extensive use of leverage by individuals, corporations, hedge funds and private equity managers has led to a significant increase in the demand for models that analyze credit risk exposures. For many users, the credit risk function has evolved from models used to analyze the quality of an individual borrower to models that aggregate exposure across borrowers, industries and geographic regions. This course provides an extended overview of the exciting and rapidly developing field of credit risk analysis.
Prerequisite(s): [(MSF 554)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 566
Time Series Analysis
This course develops a portfolio of techniques for the analysis of financial time series. Distribution theory covers the normal, student T, chi-squared, and mixture of normal models. Technical analysis covers a variety of trading rules including filters, moving averages, channels, and other systems. The first two topics are then combined into an analysis of non-linear time series models for the mean. The course concludes with a review of volatility models including GARCH, E-Garch and stochastic volatility models.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 567
Bayesian Econometrics
Most statistical applications in finance require that the forecasting models be revised in response to the arrival of new information. This course develops the Dynamic Linear Model (DLM) as an updating model based upon Bayesian decision theory. Applications of the DLM including regressions, autoregressions, and exponential trend models will be covered. Special emphasis will be given to the development of intervention and monitoring systems and the use of simulation methodologies. Students not familiar with matrix algebra and elementary statistics should plan to make up the deficiency early in the course.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 574
.NET and Database Management
The course provides students with a comprehensive knowledge of .NET (VB and C#) programming, relational database design and SQL as they apply to quant finance and real-time trading. Specifically, topics covered include the .NET framework and libraries, ADO.NET, OOP, generics, market data feeds, XML and the Unified Modeling Language, as well as an overview of the hardware and network infrastructure necessary to enable electronic trading.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 575
C++ with Financial Markets
This course presents the C/C++ programming language. Students learn the language from the ground up, from data types, to functions, arrays, classes, dynamic memory management, data structures and the Standard Template Library. Object-oriented programming is also discussed, including a review of commonly used design patterns. The focus is to understand C/C++ as it applies to financial mathematics and several practical examples from computational finance are presented.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 576
OOP and Algorithmic Trading Systems
In this course, students learn advanced programming topics in .NET for real-time financial applications and automated trading systems, including multithreading, sockets, APIs, synchronization, the FIX and FAST protocols, and object oriented design for event-driven applications. Also, project management and software quality are covered in depth. Lastly, topics related to latency in real-time financial applications and alternative network architectures are also discussed. Students are expected to propose, design, document and develop an original project combining concepts from quantitative finance and trading strategy (presented in other courses) into a working software application.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 577
High Frequency Finance
High frequency trading is concerned with the development of robotic trading algorithms within a real time market environment. This course will be concerned with the development of high frequency models and the assessment of their performance.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 584
Equity and Equity Derivatives Trading
This course will provide students with an opportunity to learn the latest Equity Trading Strategies used by large banks, brokerages and hedge funds. The instructor will present strategies on equity option trading, pairs trading, program and basket trading, risk arbitrage trading, structured product trading, and dispersion trading (time permitting). Equity trading theory and practical examples will be discussed. Students will be required to structure and adapt equity trading positions based on a range of actual and theoretical market conditions. In addition, students will collaborate with each other and the course instructor to analyze and evaluate the implementation of the above-mentioned strategies.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 585
Foreign Exchange Market and Fixed Income Strategies
The foreign exchange market is the largest and most liquid financial market in the world. Some trading strategies utilize foreign exchange as an independent asset class while others utilize foreign exchange as a component of a global strategy in equities and fixed income instruments. This course starts with strategies specific to the foreign exchange market and evolves to include short term interest rate instruments and global bonds. Fixed income trading will focus on yield curve strategies, basis trading, and various types of spread trading. Swaps, swaptions, caps, collars, and floors will be introduced.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 591
Global Financial Markets
This course will enable the student to understand the basics of financial markets and how they function in the global arena. The student will learn how the equities market, the bond market, the money market, the foreign exchange market and the derivatives markets are set up and operate. We will focus on the instruments, the players, the jargon, the details of the trade, and the institutional framework for each market. We cover both OTC and exchange-traded markets, and explore the dramatic transformation of these markets. The student will learn how each of these markets operates in the US, but will also learn how practices differ in Europe, Asia and Latin America.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 593
Market Microstructure
Market microstructure is one of the youngest but most rapidly growing areas of finance. It focuses on the organization of traded markets, including those for equities, bonds, money market instruments, foreign exchange and derivatives (including futures, options and swaps). It explores the concepts of liquidity, transparency, the information content of bids, offers and trades, information asymmetries, order flow externalities, principal-agent problems, the design of markets, the rules of markets, the volatility of markets, the failure of markets, the regulation of markets and the costs of trading. Empirical work in this area typically involves huge datasets. Students will leave this course with a thorough understanding of the structure of the markets in which they will likely spend their careers.
Prerequisite(s): [(MSF 504 and MSF 505)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 595
Entrepreneurial Finance
Most new ventures are not created by financial analysts. However, the success of a new venture is vitally dependent upon the strength of its financial controls. Knowledge of finance is also an important determinant of an entrepreneur's ability to convey information about his company to banks, regulators, and potential investors. This course provides entrepreneurs with the financial knowledge that they require to create successful new ventures.
Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 596
The Venture Capital Process
Venture capitalists are involved with the funding of new enterprises. The funding process begins with the review of a business plan submitted by the enterprise. If the business plan is accepted, the venture capitalist must then decide on the form of financing, the participation in the enterprise, and the compensation structure for the new enterprise. The course will introduce students to the process of venture capital financing and will allow them to participate in the process by reviewing actual business plans submitted by the entrepreneurs. Students will be required to evaluate the business plans and determine the type and quantity of financing to be provided.
Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)]
Lecture: 3 **Lab:** 0 **Credits:** 3

MSF 597
Independent Study in Finance
MSF 597 Independent Study allows students to undertake research projects under the supervision of a full time faculty member.
Credit: Variable

MSF 599
Special Topics in Finance
Special topics in finance.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 501
Essentials for Public Management in a Complex Society: Processes, Structures, and Values
This course provides an understanding of the fundamental theories, key practices, and underlying issues that provide the framework for contemporary American public administration. It will discuss the political and administrative values affecting the theory and practice of public administration in the United States; review the historical development of American public administrative systems and processes; examine key issues facing public administrators in the light of both traditional and contemporary values and views; critically evaluate administrative approaches to public service delivery; and explore contemporary strategies to address critical problems in a rapidly changing world, such as new public management, public private partnerships, and strategic competitiveness.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 502
Leading and Managing Knowledge-Intensive Organizations
PA 502 builds awareness and understanding of the behavior of individuals and groups in organizations, preparing managers to be more effective within their organizational contexts. Topics include individual differences in motivation, perception, culture and learning style, group and organizational dynamics, and the impact of organizational structure and culture on behavior. Leadership techniques for influencing other organizational members, creative problem-solving and decision-making, ethics and values-based managing are covered. This course helps students relate basic theories, concepts, and techniques to real-world situations through the extensive use of case studies.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 503
Administration Law
This course considers the role of statutes, case law, and administrative law in the establishment, operation, and control of public agencies. It also examines how legislation and administrative procedures direct and constrain the exercise of discretion by public managers and how they ensure accountability and the fair treatment of the public.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 505
The Law and the Nonprofit Sector
This course is an examination of local, state, and federal law as it pertains to the nonprofit sector. This includes such things as the IRS, lobbying, human resources, property, and contracts.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 506
Managerial Economics
This course examines the behavior of firms and households and the determination of prices and resource allocation in market economy. Topics include empirical demand, production and cost functions, monopoly, oligopoly, and pricing practices.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 510
Managerial Communications
This course provides hands-on training and practice in the styles of writing and related communications skills needed by all public managers, including memoranda, letters, and formal reports. Emphasis is placed on learning and practicing effective writing and communication related to real-world administrative and managerial situations relevant to the student's particular current or chosen professional position.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 511
Comparative Public Administration
This course provides an introduction to comparative analysis of systems of public administration in selected nations, including Great Britain, Japan, China, and major non-governmental organizations such as the European Union and the United Nations. The nations and organizations discussed will be compared to each other and to the United States. Areas explored will include: the historical antecedents of current national administrative systems (including the development of the nation-state), public administration models and structure in both developed and developing nations, the relationship between bureaucracies and political systems, the rise of the international nongovernmental organization, and the impact of corruption on public administration. (3-0-3)
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 512
Public Advocacy
The goal of this course is to assist students functioning as strong advocates in their future careers and to help them prepare for their thesis or final project presentation. This is an advanced research and writing course. Public Advocacy is the study of effective argument. The course is designed to allow students to focus their prior learning experiences through problem analysis and advocacy. Using individual topics, students will address the problems of advocacy including different types of advocacy situations requiring different information, analyses, and presentations. Substantive topics of current interest and controversy will be discussed in the context of developing and advocating a particular position.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 514
Government Management and Information Systems
A practical introduction to database management programs. Demonstrates the use of a variety of other office automation software tools (including graphics, desktop publishing, telecommunications/file transfer, bibliographic text retrieval, computer-aided instruction, and expert systems). Considers issues relating to effective computer management, including computer ethics, security, needs assessment and training. Prior working knowledge of personal computer operating systems, word processing, and spreadsheet programs is needed .
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 516
Information Technology in Public Administration
The course has the learning objective of becoming aware of the general management challenges that the use of information technology presents for governments and to be able to develop appropriate policies that address these challenges. Upon completion, students should be able to apply best practices to the management of computer hardware, software, networking, and other technologies in government and appreciate how the use of electronic government technology can transform government and be able to help governments develop and manage effective programs of e-government use.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 522
Effective Management of Human Resources in Environments of Scarce Resources
This course focuses on human resource planning, recruitment, examination, and promotion of procedure. It familiarizes students with the key human resources management factors involved in supervising employees as well as collective bargaining, affirmative action, and employee productivity and performance evaluation. It is directed towards practical applications in dealing with these topics as managers and employees working in their teams or individually and covers employee professional responsibility and behavior. Students in this class will learn to utilize human resource planning, recruiting, interviewing and selection processes to improve organizational outcomes; analyze the legal/cultural aspects of personnel when making organizational decisions; identify the key components of performance management to improve themselves and their direct reports; develop specific solutions to solve critical workplace personnel issues; and apply a variety of motivation and team performance techniques in current and future organizational settings.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 532
Managing Public Financial Resources in a Changing World
Managing Public Financial Resources in a Changing World exposes students to fundamental concepts and strategies of public financial resource management in a rapidly changing fiscal environment. It provides students with the concepts and skills needed to evaluate budget processes and documents, understand the role of politics and planning in financial management, and to evaluate the financial condition of governments. Emphasizing best practice models and case studies, the course will focus primarily on local government finance with some reference to state government policies and practices. Some references also will be made to nonprofit budgeting accounting practices.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 533
Advanced Financial Management for Public and Nonprofit Sectors
An advanced course focusing on the application of techniques used by financial managers to evaluate government financial condition and performance. Students will conduct case studies in which they apply tools such as performance measurement, budget analysis, priority setting, and financial indicator analysis to evaluate core public financial documents including budgets, capital improvement plans, and audited financial statements.
Prerequisite(s): [(PA 532*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 534
Financial Management in the Nonprofit Sector
Nonprofits are business organized on many of the same principle as for-profits, but there are differences including financial reporting to boards of directors, donation accounting, reporting to government funding sources, tax reporting, and even investment strategies (for example program related investing). This course will equip a nonprofit manager to responsibly guide the complex financial life of a modern nonprofit.
Prerequisite(s): [(PA 532)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 535
Resource Development in the Nonprofit Sector
Resource Development in the Nonprofit Sector provides insight and learning into fundraising, marketing, and strategic planning in the nonprofit sector. This course offers an in-depth look into finding and securing the resources necessary to the success of nonprofit organizations.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 536
Strategy and Structure: Homeland Security
This course introduces the student to the National Strategy for Homeland Security and describes the structure under which it was originally designed, the events that have affected the original concept and the various changes that is has undergone since the events of 09/11/2001. The student will become intimately acquainted with the key legal parameters affecting HS and the government components involved in HS operations, enforcement and intelligence. An emphasis on the overall integration of state, local, tribal, and private sectors will enable the student to apply the tenets of HS to their own individual situations. Other topics will include an understanding of how to conduct Threat Assessments as well as a cursory understanding of the Intelligence Cycle.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 537
Crisis Management and Homeland Security
This course is taught by experts from various disciplines and provides a basic overview of homeland security including a brief history of terrorism. Specifically, the course is intended to provide the issues related to homeland security, awareness on the types of threats (damage to building processing plants, public facilities, etc.), and the type of risks involved. Other relevant aspects include types of weapons used by modern terrorists; how one goes about estimating risk and threat to a facility; how buildings and people respond when subjected to blast and fires; the role of search and rescue operation; weapon effect; building security; facility analysis to identify vulnerable areas given a threat; procedures for minimizing vulnerability; effective fire safety; contingency plans, etc. At the conclusion of this course the student will know how to estimate the risk and threat to a given facility, prepare a basic security audit; develop a basic contingency plan, develop passive/active security system for a given facility and develop post event search and rescue operations.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 538
Information Systems Security and Cyber Crime
Provides an introduction to information systems security, an in-depth review of topics in cyber-crime issues in the public safety field and identifies methods of preventing cyber-crime in organizations. It includes issues involved with policy and legal issues of enforcement of cyber-crime laws, as well as tools used for network security.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 539
Local Government Management
This course examines the governmental structure in which public safety administrators work and studies the interrelationship of public safety administrators with the rest of the organization. The leadership and management roles of public safety officials, finances & budgeting in local government, and ethics in the profession will be examined.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 540
Alternative Dispute Resolution
This course will introduce you to the formally accepted varieties of resolving disputes without going to court: negotiation, mediation, fact-finding, mini-trials, court sponsored settlement procedures, and arbitration. We will focus on process: what each term means; how the different processes work and compare with one another; when they can and cannot be used more effectively and how; and what considerations, techniques and/or factors make each kind of process work best. This is a survey course to give a general idea of the different kinds of alternative dispute resolution methods. Although simulations are used it is not equivalent to a full skills training program. Note: This course is also applicable to the nonprofit sector.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 541
Performance Measurement in Nonprofit and Public Management
Performance management is a process of measuring progress toward specific organizational goals and objectives through the use of quantitative indicators of efficiency, effectiveness and quality. It is an essential tool that can help nonprofit and government leaders and staff plan and manage the programs and services they offer to customers, clients, and the public. This is an applied course which will help students understand performance management concepts, develop specific performance measures, and apply performance management techniques to solve real world problems in both the nonprofit and public sectors.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 543
Public Policy, Nonprofits, and Philanthropy
This course examines the long history of charitable giving across the globe with special emphasis on the United States. In particular this course will focus on the philosophical roots of philanthropy, organized giving, and the role philanthropy has played in the development of modern public policy as it pertains to health and human services.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 550
Social Entrepreneurship
This course gives students a practical introduction to the exciting and rapidly growing field of social entrepreneurship. The course will begin by introducing students to contemporary understandings of poverty, its causes, and traditional poverty alleviation strategies. It will then turn to key concepts regarding social ventures including entrepreneurship, organizational structures (for profit, nonprofit, and hybrid), financing, marketing, and performance assessment (social and environmental impact). We will also examine the challenges that are faced in creating and operating social enterprises in different parts of the world. The course includes guest lectures by the Stuart School of Business faculty and social entrepreneurs working in different areas (such as health, education, and environment). Students will gain hands-on experience by either developing a business plan for a social enterprise to address a specific real world problem or assisting an existing social venture in developing a business plan geared towards an expansion of its services. It is expected that the plans can be entered into a variety of social venture competitions.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 551
Public Infrastructure Management
This course considers the status and operation of public infrastructure facilities in the United States generally and in the Chicago metropolitan area, with particular attention to the responsibilities and roles of the public works manager. Explores the relationship between the engineering, administrative, and political aspects of public works management. Focuses on critical infrastructure issues through case studies.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 552
Human Services Policy and Administration
This course examines the major issues associated with the administration and operation of social welfare and health services in the United States by governments and nonprofit organizations. It is designed for students who work in such agencies and for those who have regular contact with them or their clientele. Structure, funding, staffing and other operating characteristics are examined.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 553
Public Safety Administration
This course deals with contemporary public safety and security management in communities for public safety professionals, public administrators, and law enforcement officials who deal with public safety issues existing in post-9/11 American society. Examines the relationship between police/public safety policy, operations, and administration. Addresses various current problems and issues through case studies. Focuses mainly on the City of Chicago and surrounding metropolitan area.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 555
Introduction to Urban and Regional Planning
The subject of this course is governmental and private sector activities that influence the maintenance and development of the built environment. Students learn both quantitative and qualitative analysis and are introduced to planning systems incorporating fiscal analysis, social analysis, transportation analysis, and demographic and economic analysis. They will also learn about various processes providing participation and citizen input to the development of plans for the built environment. Regulatory tools covered include zoning, comprehensive plans, neighborhood planning, and subdivision regulation.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 556
Public Management Strategies for the 21st Century
In the United States, an increasing proportion of the goods and services traditionally provided by governmental employees in the context of a governmental bureaucracy are now provided by outside contractors, or through indirect means such as social, economic regulation, tax policy, loan guarantees, vouchers, and manipulation of incentives for the private sector. This course is intended to provide students with an understanding of various tools used by governments throughout the West as the traditional rule-based bureaucracy is replaced by other types of institutions and other means to provide goods and services traditionally provided by government.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 557
Urban and Regional Development
This course covers materials on infrastructure management and the interrelationship of infrastructure management to urban and regional development. The course acquaints students with the increasing role of the private sector in infrastructure maintenance, development, and management. Students learn various analytic techniques useful for officials responsible for urban and regional development (including development of new infrastructure) and for the continuing maintenance and management of existing infrastructure. Students learn analytic techniques relating to management and planning.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 558
Energy and Environmental Policy
This course requires successful completion of at least one other course marked with a satisfaction of IIT's Basic Writing Proficiency Requirement. This course places energy and environmental policy in domestic and global contexts. It also traces the economic and political implications of dependence on fossil fuels and the attempt to develop alternate energy sources and promote conservation. It assesses the environmental effects of resource consumption and the effort to control these effects by increased efficiency and regulation of pollution, and explores such problems such as nuclear waste, acid rain, global warming, and deforestation. Finally, it examines national and international attempts at economic, political, and technological solutions.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 559
Issues in Globalization
Globalization has become a powerful buzzword in social science and in popular discourse. This course utilizes a sociological perspective to examine the economic, socio-political, and cultural aspects of globalization within the context of contemporary debates about the phenomenon.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 560
Political Economy
This course is an introduction to political economy exploring the relationship between economy and government or political system. Role of the state, role of the market, and impact of economic ideologies on political and economic systems will be examined. Structure of political and economic interests and the mediating effects of institutions on political and economic outcomes will be examined. Normative issues connected to ideal political and economic institutions and appropriate political and economic institutions and outcomes will be examined. The impact of the political and economic institutions on the problems of public administration at both the national and state level will be covered as well as the appropriate role for administrators, elected officials, and private sector leaders in the formulation of political and economic policy.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 561
The Political Process and Administration
This course addresses the relationship between democratic institutions and processes of American politics and the administrative agencies of government. It also examines obligations of citizenship, influence of private interests (especially economic) on public purposes, and effects of demographic, economic, and technological change on self-government.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 562

Urban and Metropolitan Government

This course analyzes the decision-making process in urban and metropolitan government. It is designed to emphasize the role of elected and appointed officials, business, organized labor, community organizations, and the electorate. It also focuses on the major problems of city-suburban relations.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 **Lab:** 0 **Credits:** 3

PA 565

The Nonprofit Sector

This course considers the role played by the nonprofit sector in the larger American society and economy. Topics include major organizational forms, financial management, human resource policies, leadership, board-executive relations, and private-public connections.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 **Lab:** 0 **Credits:** 3

PA 566

Nonprofits and the Public Sector

Nonprofits and the Public Sector provides an overview of the complex and important relationship between government and nonprofits. This course includes a review of the history, funding schemes, the differences between grant and contract funding, recent trends, and more.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 **Lab:** 0 **Credits:** 3

PA 567

Regulatory Policy and Politics

This course examines the changing role of government regulation of private and public activities from a political and administrative perspective. It also explores the reasons for growth and reform of economic and social regulation and investigates the regulatory process including standards for rule-making and the involvement of organized groups and the courts.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 **Lab:** 0 **Credits:** 3

PA 568

Strategic Competitiveness in the Public Sector

This course is a strategy, competitiveness, and leadership laboratory for public sector managers and leaders of the 21st century. Students will gain an understanding of IIT Stuart's unique core concept of strategic competitiveness as well as frameworks from theories of entrepreneurial government, strategic management, and economic competitiveness. Students will critically analyze conventional frameworks for relevance to various contexts across the public sector in the rapidly changing Next Economy. Cases discussing the public sector's efforts to transform its management processes to meet the challenges of the Next Economy and to successfully interact with the business community are emphasized. The course employs a dynamic classroom environment using case method, class discussions, and group projects. Students will appreciate the challenges, complexities, and characteristics needed to effectively lead and be successful in the competitive global economy by delving into questions such as: How do countries, regions, states, and cities compete in the global economy? How do public leaders create innovative economic development strategies by influencing firms' strategic decisions regarding investment and trade? How can public leaders enhance the competitiveness of their business environment by adopting entrepreneurial government strategies? What are best practices for economic development in the Next Economy?.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 **Lab:** 0 **Credits:** 3

PA 570

Social Capital and the Community

The 21st century confronts the public sector with new challenges and opportunities. Many of these challenges and opportunities will take place on the community level, and many of those challenges and opportunities will be centered on the notion of social capital and the community. Social capital means the building of and use of community assets -- those resources available to the community through its residents or citizens, association, institutions, and economic life. Using an asset-based community development approach, the objective of this course is to help the student understand and use the concepts of asset-based approaches to social capital and community as it relates to public administration.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 **Lab:** 0 **Credits:** 3

PA 577

Topics in Public Management

This reading and seminar will focus on a contemporary topic in public administration or policy. Subject matter will change in successive offerings of the seminar.

Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.

Credit: Variable

PA 578
Planning, Policy-Making, and the Built Environment
This course introduces students to governmental planning, policy-making, and their impact on the built environment. Using Chicago and nearby municipal areas as examples, the course acquaints students with the basic theories of urban and regional planning and development, and the regulatory tools and techniques used by government to impact the built environment. The course also includes material on housing, environmental protection, brownfields, historic preservation, new-urbanism and growth management, and various policy-making processes that determine governmental policies intended to influence the built environment.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 579
Ethics and Professional Responsibility in Public Service
This course focuses on the ethical problems and issues faced by individuals in public service organizations. It also examines questions related to corruption, abuse of power, financial impropriety, ethics codes and standards in government and professional fields, whistle-blowing, and other topics related to front-page concerns and individual problems of conscience and judgment. The course traces the growth of concern about the standards of ethical behavior in government in the U.S.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 580
Policy Evaluation Analytics
This course will present a variety of tools and techniques to evaluate existing programs and policies to determine and measure their most important elements, and to give policy-makers the necessary information to fund, improve or terminate programs based on empirical evidence regarding factors such as cost/benefit, efficiency, effectiveness, equity, and other important characteristics. Evaluation can also allow policy-makers and staff to focus budgets and efforts to best achieve policy or program goals.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 581
Policy Design Analytics
This course is designed to present practical, cost-effective techniques that can be used to make better decisions regarding the allocation of scarce resources. Topics covered include problem identification, goal development, data needs and collection, generation of alternative solutions, projecting impacts, goals-oriented evaluation, and strategies for implementation.
Prerequisite(s): [(PA 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 588
Incident Response, Disaster Recovery, and Business Continuity
Students learn to design and manage key business information security functions including incident response plans and incident response teams; disaster recovery plans; business continuity plans; and crisis management teams and plans. Reporting, response planning, and budgeting are all addressed. Students working in teams will prepare an incident response, disaster recovery, business continuity, or crisis management plan for a real world organization such as a business or a government body or agency.
Prerequisite(s): [(PA 501*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 590
Internship in Public Administration
This course provides practical experience in public administration and may be taken only by students lacking extensive work experience in governmental administration.
Prerequisite(s): [(PA 501)]
Credit: Variable

PA 592
Directed Readings in Public Administration
This course consists of independent reading and analysis centered on particular problems and supervised by a member of the public administration faculty.
Credit: Variable

PA 597
Special Problems
The subject matter of this course will vary with the interests and the background of the students and the instructor, and the course may be taken more than once. Instructor permission is required.
Lecture: 3 **Lab:** 0 **Credits:** 3

PA 599
Integrative Practicum for Effective Leadership in Public and Nonprofit Organizations
PA 599 is a capstone course where students apply concepts and theories they have studied to analyze an organizational or policy problem and deliver a report that normally specifies the problem or task, defines alternatives, and proposes recommended course of action. The recommendation will be supported by reasons and evidence. PA 599 should be taken in the student's last semester.
Prerequisite(s): [(PA 580*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 **Lab:** 0 **Credits:** 3

PCA 500
Professional Communication
Lecture: 3 **Lab:** 0 **Credits:** 1.5,3

PCA 510
Communication Essentials
This course will prepare students to communicate effectively with native speakers in a variety of settings by teaching language strategies, phrases, linguistic structures, and vocabulary in English. The course will focus on initiating, maintaining, and ending basic conversations. Understanding cultural context and responding appropriately will be emphasized. Prerequisite: Department approval only; determined by assessments.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 515
Strategies for Effective Communication
Students will incorporate subject material learned in PCA 510 and use the knowledge gained to develop higher communicative fluency in order to discuss topics with more competency. This course will focus on developing students' ability to build and sustain communication across a variety of settings with an emphasis on asking for and providing information, expressing feelings, asking for and giving advice, and asking for and giving opinions. Prerequisite: Department approval only; determined by assessments.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 520
Advanced Communication Skills
Students in this course will learn higher-level communication strategies necessary to achieve individual goals in academic and business environments. Students will also focus on the language and cultural knowledge needed to work collaboratively in the U. S. workplace.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 525
Advanced Presentation Skills
Students will incorporate course material learned in PCA 520 to practice speaking and presenting on a wide variety of topics. Interviewing skills, group participation, numerical analysis, and public speaking will be covered in the course. Throughout the course, students will give presentations that demonstrate sophisticated vocabulary and advanced communication skills.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 530
Writing for Academic and Professional Success I
The course offers strategies for students to learn and practice ways to express themselves clearly in writing. Students will learn to write effective, organized, coherent paragraphs and longer writing forms by focusing on the following: brainstorming and planning; topic sentences and thesis statements; transitional words and phrases; the American organization style; grammar; proofreading; and editing.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 540
Writing for Academic and Professional Success II
The course includes a review and refinement of English grammar to produce clear, concise, and polished writing. Students will build on paragraph development to write with greater complexity and logical organization of outside support with special focus on proper reference and citation techniques.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 550
Writing for the U. S. Workplace
Students in this course will learn the higher-level business writing tasks and writing skills needed to effectively communicate using various business formats.Students will learn and practice appropriate language structures, phrases, and vocabulary commonly used in American business writing. Prerequisite: Department approval only; determined by assessments.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

PCA 570
Advanced Strategies for Clear Communication
Students will learn pronunciation strategies to communicate more effectively with others in English. There are many individual components necessary for good English pronunciation and this course will focus on the most important components for improving overall intelligibility: word stress and rhythm patterns; sounds in connected speech; and intonation. Students will be taught strategies for both identifying these patterns in the speech of native speakers as well as integrating them into their own speech. Students will be responsible for practicing these strategies in and out of class.
Lecture: 1.5 **Lab:** 0 **Credits:** 1.5

SMGT 500
Fundamentals of Environmental Science
This is an introductory course designed to teach students without any background in environmental science the fundamentals of environmental science which is the prerequisite knowledge needed for the Sustainability Management program core courses. It covers basics of environmental science, calculus, chemistry, and other relevant topics that represent a needed foundation for the other courses in the program. Students with prior education in environmental science or related subjects could be waived out of this course with approval from the program director.
Lecture: 2 **Lab:** 0 **Credits:** 2

SMGT 501
Environmental Policy in a Competitive World
Environmental policies, the main tools that governments use to achieve environmental goals, cut across a wide swath of pollutants, industries, and stakeholders. Environmental policies affect the daily activities of every citizen and every business. Governments use environmental policy to protect their citizens' health, develop industries, preserve resources, increase national security, and more. This course introduces students to the major rationales for government intervention in environmental affairs, the academic theories on which these interventions are based, the variety of policy approaches that various levels of government often use to address environmental issues, the benefits and drawbacks of various approaches, the political processes involved in the enviromental policy-making process, the tools that can be used to evaluate the effectiveness and tradeoffs of policy alternatives, and how these policies may affect government and business competitiveness. In addition, the course examines new directions in environmental policy, both policies gaining popularity and those not yet adopted.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 502
Contemporary and Emerging Laws Governing the Environment
This course introduces students to major federal laws that govern the environmental performance of regulated facilities, sites, and activities. The course describes why these laws were enacted, how they are implemented by regulatory agencies, and the practical measures regulated entities must employ to achieve compliance. These laws include the National Environmental Policy Act, the Clean Water Act, the Clean Air Act, the Endangered Species Act, the Resource Conservation and Recovery Act, and the Comprehensive Environmental Response, Compensation, and Recovery Act. The review of these major federal laws will be informed by international and state initiatives that also affect decision making on environmental matters. The course will include a series of case studies and skill development sessions to introduce students to the practical realities of environmental management in a complex regulatory context.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 503
Environmental Pollution Prevention and Control Strategies
Greening organizations benefit both firms and society as a whole by eliminating/reducing pollution, inventing new processes, and reducing risks. This course focuses on the design and development of environmental management strategies specific to industrial operations and economic development activities in order to make them more competitive and sustainable. Specifically discussed in this course are the techniques and tools for mapping and characterizing industrial operation and economic development activities, identifying sources and types of environmental pollution, and defining steps involved with designing pollution prevention/control strategies and their alternatives (i.e., changing inputs, increasing efficiency, promoting innovation, or adopting new technologies to either prevent emissions or treat residuals). The economics of the pollution prevention/control including cost valuation and cost-benefit analysis are covered in addition to discussing the limitations and risks.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 504
Industrial Ecology and Systems Thinking
This course introduces the students to the philosophy of industrial ecology and how this systems-based approach can move society toward a more sustainable future. Industrial ecology is an interdisciplinary field involving technology (science and engineering), public policy and regulatory issues, and business administration. The major goal of this course is to promote creative and comprehensive problem solving as it might be applied to product, business, and systems models. The course introduces tools such as industrial metabolism, input-output analysis, life cycle assessment, and design for the environment. Individual and team projects are a significant part of the learning experience in this course.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 505
Environmental Finance
The emerging field of environmental finance provides businesses an opportunity to approach environmental challenges in a financially sustainable and often profitable manner. The course will introduce students to fundamental concepts of microeconomics, macroeconomics, and accounting in order to prepare them for studying finance and other SMGT courses. It will explore implications of environmental finance on the financial sector ranging from banking, insurance, investments, financial services, sustainable investing, and social enterprise. The role of hedging devices for pollution and energy and the role of corporate advocacy in environmental policy and standards will be addressed from a corporate competitive business strategy perspective. The interrelationship between financial and environmental performance will be discussed with a focus on corporate risk management and impact on stock and bond ratings. Format will comprise of introduction of basic concepts, discussion of select current publications from corporate and academic thought leaders, and cases or examples that provide hands-on experience.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 511
Solid and Hazardous Waste Management and Remediation
The aim of this course is to teach the modern multi-faceted approach of the management of solid waste focusing on the generation and prevention (emphasis is on understanding what waste is, where it comes from, how/why it is generated, and how generation of waste can be reduced), re-use and recycling (once waste is generated, what can be done to make use of those waste components that are of economic interest), treatment (discuss the three most important treatment/disposal methods presently in use both in the less and the more developed world, landfills, incineration, and mechanical/biological treatment), and disposal of waste (examples include analysis and environmental impact assessment of land-filling and incineration). RCRA technical and regulatory points of views are covered, and discussed are evolution of RCRA legislation, components of RCRA, and its interrelationship to other environmental statutes CERCLA, SARA, and DNR hazardous waste permitting. Also discussed are the fundamentals of remedial actions, Brownfield's redevelopment, and renewable energy. The emphasis would be on the economic, social, and environmental costs of waste generation, recycling, treatment, and storage.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 512
Environmental Risk Assessment and Management
The course provides an overview of the tools and techniques used to (1) assess environmental (human health), ecological, and occupational risks associated with exposure to environmental pollutants resulting from natural phenomena, economic development, and industrial growth, (2) examine current risk management and mitigation methods and strategies, and (3) design visionary risk management strategies grounded on a framework of operations in line with the principles of sustainable development.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 513
Environmental Economics and Climate Change
An overview of the modeling market process is provided focusing on externalities, environmental problems, and environmental quality. Economic solutions to environmental problems are discussed using a market approach which includes modeling emission charges, modeling a product charge, modeling per unit subsidy on pollution reduction, and modeling pollution permit trading systems and practice. The course examines institutional economic solutions to address environmental problems such as climate change, global warming, and water scarcity.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 518
Ethics and Corporate Social Responsibility
The corporate scandals and implosions of the past decade, climaxing in the recent global financial crisis and environmental disasters, have highlighted how critical ethical, environmental, and socially responsible decision making and leadership are to the long-term survival and success of both individual businesses and society. Concomitantly, the role of business is transforming from meeting a social contract to realizing tangible economic gains by creating shared value. In today's global environment, societal needs are defining markets, and key issues include poverty, hunger, water, sustainability, climate change, and MNC roles in developing economies. Ethical issues include bribery, fraud, and green washing all the way to a culture of corruption. Corporations and leaders have to manage corporate social responsibility not just as a moral obligation or risk/reputation management exercise but as an integration into their global strategy. This course will endeavor to teach students how these issues get integrated in business through strategy and structure and how to build new competencies in managing transparency, accountability, stakeholder engagement, ethics culture, and social innovation that are critical for business success in the next economy.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 525
Environmental Performance Analytics
With increasing focus on sustainability factors from marketplace (regulators, investors, financiers, and consumers), corporate sustainability reporting is shifting from voluntary to vital. Advances in enterprise systems are making it feasible for corporations to track, trend, and transform sustainability performance. Materiality of these seemingly non-economic impacts is the critical link between sustainability and business strategy. This course provides insight into how to determine which environmental metrics are material to them and relevant to their business through application of environmental performance analytics. Format will comprise of introduction of basic concepts, discussion of select current publications from corporate and academic thought leaders, and short cases or examples that provide hands-on experience. Students completing this course will develop a better understanding of the materiality of interrelationships between business and sustainability. In particular, they will equip themselves with the ability to apply data collection, analytics, and quantitative justification to promote select sustainability improvements that are consistent with corporate strategy. This will help them to be better prepared to take on greater responsibilities in a consulting or advisory role to the corporate sector.
Prerequisite(s): [(BUS 550)]
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 526
Sustainable Supply Chain Management
Students will be presented with models and practices that minimize supply-demand mismatch and therefore maximize companies' own profitability as well as models and practices of collaboration with other companies in a supply chain that minimize risk and environmental costs and therefore maximize the supply chain's sustainability. This course will have an emphasis on the integration of business and technology aspects. We will first introduce an integrated view of the production and logistics functions in organizations such as capacity analysis, inventory management, and logistics management. The course then discusses topics involved in the interaction of a firm with others players in a supply chain such as valve of information, supply contracts, and risk sharing. Finally, the course will introduce models/tools enabling sustainability actions plans, for example, reducing waste in the supply chain, both upstream and downstream.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 529
Social Entrepreneurship
This course gives students a practical introduction to the exciting and rapidly growing field of social entrepreneurship. The course will begin by introducing students to contemporary understandings of poverty, its causes, and traditional poverty alleviation strategies. It will then turn to key concepts regarding social ventures including entrepreneurship, organizational structure (for-profit, non-profit and hybrid), financing, marketing, and performance assessment (social and environmental impact). The course will also examine the challenges that are faced in creating and operating social enterprises in different parts of the world. The course includes guest lectures by other Stuart School of Business faculty and social entrepreneurs working in different areas (such as health, education, and environment). Students will gain hands-on experience by either developing a business plan for a social enterprise to address a specific real world problem or assisting an existing social venture in developing a business plan geared towards an expansion of its services; it is expected that the plans can be entered into a variety of social venture competitions. Through the course, students will learn how to do the following: (1) evaluate gaps and opportunities in a given context; (2) develop appropriate objectives and strategies for a social venture; (3) put together a business plan for a social enterprise; and (4) engage others and foster buy-in to their plans.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 531
Environmental Advocacy
This course explores how individuals, firms, nonprofits, and others advocate in order to achieve environmental goals using a broad range of advocacy tools in the legislative, regulatory, administrative, political, judicial, and educational arenas. The course examines when, where, and how advocacy can be effective, strategies for framing policies, how to evaluate legal and ethical factors, and how to use traditional as well as grassroots, social networking, and other evolving new media methods to support an advocacy campaign.
Prerequisite(s): [(SMGT 501)]
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 532
Environmental and Energy Law Clinic
This course provides students with the opportunity to experience the practical realities of being an environmental professional by working on actual cases under the supervision of a faculty member who is an experienced environmental attorney with a Chicago-based practice. The course includes weekly classroom sessions to build the skills environmental professionals must possess. Students apply these skills to cases in the Chicago area in which the faculty supervisor represents non-governmental organizations. The Clinic includes opportunities to participate in site visits, client interactions, a variety of professional meetings, and regulatory and enforcement proceedings. Students will engage in fact gathering, compliance analysis, client communication and case preparation activities, working alongside their faculty supervisor.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 541
Managing Energy Technologies
A significant focus of this course will be on what environmental managers and business managers need to know regarding the technical aspects of energy management -- energy efficiency and fossil and renewable energy technologies. The thrust of the course will be in understanding current and emerging technologies in this rapidly growing area of business and industry. However, students will not need to have technical or engineering background to do well in this course.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 542
Economics of Energy Systems
Students will see the big picture economics of energy management -- cost of production/distribution, financing renewable investments, climate change, etc. Students will understand the economic, strategic, and management issues surrounding energy management and have an opportunity to learn new tools and techniques.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 595
Special Topics in Sustainability Management
This course covers contemporary or cutting edge topics in the sustainability management field offered on an irregular basis typically in a seminar style. Prerequisite: Instructor permission.
Lecture: 3 **Lab:** 0 **Credits:** 3

SMGT 597
Independent Study in Sustainability Management
Students can conduct in-depth research, usually on an independent and solo basis, under the guidance of a full-time faculty member. Typically, a student signs up with a faculty member who is willing to supervise his/her independent research on a particular sustainability management-related topic. The student has to complete the independent study form, develop a one-page proposal outlining the purpose, process, and product (expected outcomes) of the independent research project, get the faculty member's approval, and submit it to the program director for approval. Prerequisite: Instructor and program director approval.
Lecture: 0 **Lab:** 0 **Credits:** 1.5,3

SSB 510
Advancing Career and Education: Foundational Career Competency Development
The two-semester Advancing Career and Education (ACE) Program is a graduation requirement that complements the graduate business student's academic experience and prepares the student for professional internship placement and the post-graduation job market. Aligned with the Stuart Educational and Professional Development Competency Model, the first semester course (SSB 510) explores topics such as cultural competence, communication skills, ethics, and leadership and teamwork. This course develops students' workplace readiness in the areas of resume development, relationships and communication, workplace etiquette, presentation skills, and time management. During the first semester, students are provided the option of completing the self-selected Career Competency Experience (SSB 511) or applying to the Industry Solutions Experience (SSB 512).
Lecture: 1 **Lab:** 0 **Credits:** 0

SSB 511
Advancing Career and Education: Career Competency Experience
The two-semester Advancing Career and Education (ACE) Program is a graduation requirement that complements the graduate business student's academic experience and prepares the student for professional internship placement and the post-graduation job market. Aligned with the Stuart Educational and Professional Development Competency Model, the second semester course (SSB 511) focuses on internship search and interviewing skills including demonstrating business competencies, LinkedIn strategies and tools, networking and informational interviewing, and understanding employer expectations. To satisfy the experiential component of the ACE Program, students in SSB 511 must select and develop specific competencies from a list of career-relevant skill areas. Students will then participate in a self-selected experiences and write a reflection paper for each experience in which they discuss its relevance to their career objectives and the competencies they selected.
Prerequisite(s): [(SSB 510)]
Lecture: 1 **Lab:** 0 **Credits:** 0

SSB 512
Advancing Career and Education: Applied Industry Experience
The two-semester Advancing Career and Education (ACE) Program is a graduation requirement that complements the graduate business student's academic experience and prepares the student for professional internship placement and the post-graduation job market. Aligned with the Stuart Educational and Professional Development Competency Model, the second semester course (SSB 512) focuses on client relationship management, consulting skill development, research application, and problem-solving in addition to internship search and interviewing skills including demonstrating business competencies, LinkedIn strategies and tools, networking and informational interviewing, and understanding employer expectations. To satisfy the experiential component of the ACE Program, students in SSB 512 participate in a team-based workplace experience hosted by a partner organization. Students will receive mentorship from a company representative and an opportunity to present a business solution to the organization.
Prerequisite(s): [(SSB 510)]
Lecture: 1 **Lab:** 0 **Credits:** 0

Master of Business Administration (M.B.A.)

The Master of Business Administration requires the successful completion of at least 48 semester credits (16 courses). Full-time students are expected to enroll for at least three courses per semester and can potentially complete their program in two-and-a-half years. Part-time students may enroll in as few as one course per semester and complete their program at a slower pace. The program schedule allows flexibility to students who wish to accelerate their studies. For example, full-time students may graduate in roughly two years by taking more courses each semester and attending school during the summers—but this requires careful planning.

Curriculum

Core Courses		(33)
BUS 510	Building an Innovative and Sustainable Business	3
BUS 550	Business Analytics for Competitive Advantage	3
BUS 590	Business Innovation in the Next Economy	3
MBA 501	Accounting for Strategic Decision-Making	3
MBA 502	Emerging Issues in the Global Business Environment	3
MBA 504	Analytics for Decision Making	3
MBA 505	Contemporary Economic Analysis and Game Theory	3
MBA 506	Leadership in Knowledge-Intensive Organizations	3
MBA 509	Financial Management in a Globalized World	3
MBA 511	Creating, Communicating, and Delivering Customer Value	3
MBA 513	Operations and Technology Management	3
Elective Courses		(15)
Select 15 credit hours		15
Total Credit Hours		48

Concentrations

A concentration consists of a minimum of 6 credit hours in one of the following areas:

- Business Analytics
- Business and Society
- China Studies
- Corporate Finance
- Creativity and Innovation
- Emerging Markets
- Investment Management
- Management of Nonprofits
- Management of Public Sector
- Risk Management
- Strategy and Leadership
- Sustainability
- Technopreneurship
- Technology and Marketing

Master of Business Administration (Accelerated MBA)

Foundational Courses			(6) [1]
BUS 510	Building an Innovative and Sustainable Business		3
MBA 501	Accounting for Strategic Decision-Making		3
Core Courses			(24)
BUS 550	Business Analytics for Competitive Advantage		3
BUS 590	Business Innovation in the Next Economy		3
MBA 504	Analytics for Decision Making		3
MBA 505	Contemporary Economic Analysis and Game Theory		3
MBA 506	Leadership in Knowledge-Intensive Organizations		3
MBA 509	Financial Management in a Globalized World		3
MBA 511	Creating, Communicating, and Delivering Customer Value		3
MBA 513	Operations and Technology Management		3
Elective Courses			(6)
Select a minimum of 6 credit hours from the following: [2]			6
MBA 502	Emerging Issues in the Global Business Environment	3	
MBA 523	Negotiations and Strategic Decision Making	3	
MBA 524	Leadership in Multicultural Organizations	3	
Total Credit Hours			36

Minimum degree credits required: 30-36

1 Students who do not need foundational courses will graduate with 30 credit hours. Those requiring the foundational courses will need 36 credit hours to graduate.

2 Other courses from Stuart's graduate programs may be approved by program director.

Master of Mathematical Finance

Collaborative program with the Department of Applied Mathematics

The objective of the Master of Mathematical Finance program is to provide individuals interested in pursuing careers in financial risk management with advanced education in theoretical, computational, and business aspects of relevant quantitative methodologies. This is a collaborative program between the Stuart School of Business and the Department of Applied Mathematics, and as such, it gives students the chance to benefit from the strength of both units. Students are required to complete a total of eleven semester courses, including eight core courses and three elective courses.

Curriculum

Code	Title		Credit Hours
Core Courses			(24)
MSF 505	Futures, Options, and OTC Derivatives		3
MSF 526	Computational Finance		3
MSF 575	C++ with Financial Markets		3
MATH 542	Stochastic Processes		3
MATH 548	Mathematical Finance I		3
MATH 565	Monte Carlo Methods in Finance		3
MATH 582	Mathematical Finance II		3
MATH 586	Theory and Practice of Fixed Income Modeling		3
Applied Mathematics Elective Courses			(3)
Select a minimum of one course from the following:			3
CS 522	Advanced Data Mining	3	
MATH 512	Partial Differential Equations	3	
MATH 522	Mathematical Modeling	3	
MATH 540	Probability	3	
MATH 543	Stochastic Analysis	3	
MATH 544	Stochastic Dynamics	3	

MATH 545	Stochastic Partial Differential Equations	3	
MATH 546	Introduction to Time Series	3	
MATH 566	Multivariate Analysis	3	
MATH 567	Advanced Design of Experiments	3	
MATH 569	Statistical Learning	3	
MATH 577	Computational Mathematics I	3	
MATH 578	Computational Mathematics II	3	
MATH 579	Complexity of Numerical Problems	3	
MATH 587	Theory and Practice of Modeling Risk and Credit Derivatives	3	
MATH 589	Numerical Methods for Partial Differential Equations	3	
MATH 590	Meshfree Methods	3	
Finance Elective Courses			(3)
Select a minimum of one course from the following:			3
MSF 524	Models for Derivatives	3	
MSF 525	Term Structure Modeling and Interest Rate Derivatives	3	
MSF 545	Structured Fixed Income Portfolios	3	
MSF 546	Quantitative Investment Strategies	3	
MSF 554	Market Risk Management	3	
MSF 555	Credit Risk Management	3	
MSF 566	Time Series Analysis	3	
MSF 567	Bayesian Econometrics	3	
MSF 574	.NET and Database Management	3	
MSF 576	OOP and Algorithmic Trading Systems	3	
MSF 577	High Frequency Finance	3	
MSF 584	Equity and Equity Derivatives Trading	3	
MSF 585	Foreign Exchange Market and Fixed Income Strategies	3	
Additional Elective Course			(3)
Select one course [1]			3
Total Credit Hours			33

1 One graduate level elective may be taken from outside the prescribed mathematical finance courses described above, provided that it is consistent with the Master of Mathematical Finance program objectives and has been approved by the program director prior to the student's registration.

Core Requirement

All mathematical finance students must complete the eight core classes unless they have obtained written permission from their academic adviser to substitute an alternative class for a core class.

Course Substitutions

To the extent that students have completed commensurate coursework or professional experience, substitutions to the required curriculum may be permitted, with the approval of the academic adviser.

Transfer Credit

Students may also transfer up to two classes from a graduate program at another accredited university if the student has not used the classes to satisfy the requirements for a degree at the previous university. Additional classes may be transferred with the permission of the program director.

Prerequisite Courses

Some students may be required to take prerequisite courses in mathematics, statistics, or computer programming before being admitted to a graduate course.

Master of Public Administration

Curriculum

The M.P.A. degree requires a minimum of 33 credit hours (11 courses) of graduate work, including 8 core courses.

Required Courses		(24)
PA 501	Essentials for Public Management in a Complex Society: Processes, Structures, and Values	3
PA 502	Leading and Managing Knowledge-Intensive Organizations	3
PA 522	Effective Management of Human Resources in Environments of Scarce Resources	3
PA 532	Managing Public Financial Resources in a Changing World	3
PA 568	Strategic Competitiveness in the Public Sector	3
PA 580	Policy Evaluation Analytics	3
PA 581	Policy Design Analytics	3
PA 599	Integrative Practicum for Effective Leadership in Public and Nonprofit Organizations	3
Elective Courses		(9)
Select 9 credit hours		9
Total Credit Hours		33

Elective courses may be selected from courses in public administration or other fields such as architecture, business, city and regional planning, civil engineering, computer science, design, environmental engineering, humanities, psychology, social sciences, or law. Taking a course outside the M.P.A. program requires the permission of the student's adviser and the M.P.A. program director. No more than 6 credit hours may be taken in university courses numbered between 400 and 499. A maximum of 9 credit hours of graduate-level coursework may be transferred from another accredited university if these have not been used toward a degree and upon approval of the student's adviser and the M.P.A. program director.

M.P.A. with Nonprofit and Mission-Driven Management Specialization

This specialization is designed for professionals who want to become leaders and managers of nonprofit and other mission driven enterprises. It provides students with the skills needed to enter the nonprofit field, advance their current nonprofit career, or become a nonprofit or mission-driven enterprise entrepreneur. Students take the regular M.P.A. core curriculum and three electives from the nonprofit courses offered in the program. This program combines rigorous instruction with a practical orientation toward mission-driven organizational management.

M.P.A. with Security, Safety, and Risk Management Specialization

The Security, Safety, and Risk Management specialization is intended for professionals who want to acquire cutting edge security strategies and leadership techniques to successfully manage public safety and public or private sector emergency preparedness programs. Students take the regular M.P.A. core curriculum and three electives from the security, safety, and risk management courses offered in the program. This program combines rigorous instruction with a practical orientation.

M.P.A. with Economic Development and Social Entrepreneurship Specialization

The specialization in Economic Development and Social Entrepreneurship is designed for professionals who want to become economic development leaders of social entrepreneurs. They will become managers and entrepreneurs who drive socially responsible economic change in a rapidly changing global environment. These professionals may work in the public sector specializing in developing cutting edge economic development strategies and programs at the local, state, or federal level or they may want to be mission-driven entrepreneurs who organize, manage, or create ventures that utilize social capital to foster local or regional economic development. Students take the regular M.P.A. core curriculum and three electives from the economic development and social entrepreneurship courses offered in the program.

Master of Technological Entrepreneurship

The objective of the Master of Technological Entrepreneurship program is to train prospective entrepreneurs and intrapreneurs who intend to start, build, and manage businesses and business initiatives that leverage technological innovation to generate competitive advantage.

Curriculum

To earn a Master of Technological Entrepreneurship, students must successfully complete 30 credit hours consisting of 24 credit hours of core courses and 6 credit hours of elective courses.

Core Courses		(24)
BUS 510	Building an Innovative and Sustainable Business	3
BUS 590	Business Innovation in the Next Economy	6
IDX 560	Analysis + Synthesis for Non-Designers	3
IDX 562	Multidisciplinary Prototyping for Entrepreneurs	3
MBA 576	Creating and Financing New Technology Ventures	3
LAW 171	Entrepreneurship Law	3
LAW 505	Business Entity Formation	3
Elective Courses		(6)
Select 6 credit hours [1]		6
Total Credit Hours		30

[1] Elective courses must be approved by the student's adviser and the program director prior to registration.

Master of Science in Finance

Curriculum

To earn a Master of Science in Finance, students must successfully complete 33 credit hours (11 courses). The typical program will consist of six core cores and five elective courses. However, students may request that they be allowed to substitute an elective course for a core course if they can demonstrate to the program director that they have already mastered the material in the core course.

Core Courses			(18)
MSF 501	Mathematics with Financial Applications		3
MSF 502	Statistical Analysis in Financial Markets		3
MSF 503	Financial Modeling		3
MSF 504	Valuation and Portfolio Management		3
MSF 505	Futures, Options, and OTC Derivatives		3
MSF 506	Financial Statement Analysis		3
Elective Courses			(15)
Select a minimum of five courses from the following: [1]			15
Alternative Investments			
MSF 543	Alternative Investments	3	
MSF 549	Commodities and Managed Futures	3	
Corporate Finance			
MSF 534	Corporate Finance	3	
MSF 535	Investment Banking	3	
Entrepreneurial Finance			
MSF 595	Entrepreneurial Finance	3	
Financial Econometrics			
MSF 566	Time Series Analysis	3	
MSF 567	Bayesian Econometrics	3	
Financial Engineering			
MSF 524	Models for Derivatives	3	
MSF 525	Term Structure Modeling and Interest Rate Derivatives	3	
MSF 526	Computational Finance	3	

Financial Markets		
MSF 591	Global Financial Markets	3
MSF 593	Market Microstructure	3
Financial Programming		
MSF 574	.NET and Database Management	3
MSF 575	C++ with Financial Markets	3
High Frequency Finance		
MSF 576	OOP and Algorithmic Trading Systems	3
MSF 577	High Frequency Finance	3
Investment Management		
MSF 544	Equity Valuation	3
MSF 545	Structured Fixed Income Portfolios	3
MSF 546	Quantitative Investment Strategies	3
Risk Management		
MSF 554	Market Risk Management	3
MSF 555	Credit Risk Management	3
MSC 622	Enterprise Risk Management	3
Trading		
MSF 584	Equity and Equity Derivatives Trading	3
MSF 585	Foreign Exchange Market and Fixed Income Strategies	3
Total Credit Hours		33

[1] Elective classes are organized into concentrations. Students who complete two or more courses within a particular concentration will have the concentration recognized on official transcripts.

Core Requirement

All Master of Science in Finance students must complete the six core classes unless they have obtained written permission from the program director to substitute an alternative class for a core class.

Course Substitutions

To the extent that students have completed commensurate coursework or professional experience, substitutions to the required curriculum may be permitted, with the approval of the program director. Qualified students may substitute courses from the Master of Mathematical Finance for elective courses in the Master of Science in Finance program.

Free Electives

Up to two graduate-level electives may be taken from outside the courses prescribed above. These electives may be taken from other offerings at the Stuart School of Business, the Chicago-Kent College of Law, or Mies Campus graduate programs, provided that:

1. They are consistent with the Master of Science in Finance program objectives.
2. They have been approved, prior to the student's registration, by the Master of Science in Finance program director or the student's academic adviser.

Students may also transfer up to two classes from a graduate program at another AACSB accredited university if the student has not used the classes to satisfy the requirements for a degree at the university. Additional classes may be transferred with the permission of the program director.

Prerequisite Courses

Some students may be required to take prerequisite courses in mathematics, statistics, or computer programming before being admitted to a graduate course. Undergraduate course offerings, which typically are listed with a primary numeral of four or below cannot be used as free electives in the Master of Science in Finance program.

Master of Science in Management Science

Curriculum

To earn a Master of Science in Management Science students must successfully complete 33 credit hours (11 courses). The typical program will consist of six core courses and five elective courses.

Core Courses		(18)
MSC 511	Economics I	3
MSC 512	Statistics I	3
MSC 513	Optimization I	3
MSC 514	Economics II	3
MSC 515	Statistics II	3
MSC 516	Optimization II	3
Elective Courses		(15)
Select a minimum of five courses [1]		15
Total Credit Hours		33

1 Elective courses may be chosen from any Stuart School of Business program, but registration in these courses requires prior approval of program director.

Master of Science in Marketing Analytics

The Master of Science in Marketing Analytics requires the successful completion of 33 credit hours (11 courses). Part-time students can enroll for as few as one course per semester and can take up to five years to complete their degree. Full-time students are expected to enroll for at least three courses per semester and can complete their degree in two years. The program schedule allows flexibility to students who wish to accelerate their studies. For example, full-time students could graduate in roughly a year by starting in summer of year 1 and completing their program in summer year 2, but this requires careful planning.

Curriculum

Core Courses		(24)
BUS 510	Building an Innovative and Sustainable Business	3
BUS 550	Business Analytics for Competitive Advantage	3
BUS 590	Business Innovation in the Next Economy	3
MAX 501	Insights into the Next Economy Markets	3
MAX 502	Analytics for Decision Making	3
MAX 503	Marketing Research & Engg	3
MAX 504	Creating, Communicating, and Delivering Customer Value	3
MAX 505	Strategic Marketing Management	3
Concentration		(9)
Select 9 credit hours in Marketing Analytics or Marketing Communication		9
Total Credit Hours		33

Marketing Analytics Concentration

MAX 521	Qualitative and Survey Research Methods in Business	3
MAX 522	Predictive Analytics	3
MAX 523	Social Media Marketing Analytics	3

Marketing Communication Concentration

MAC 511		3
Select a minimum of two courses from the following:		6
MAC 512	3	
MAC 513	3	
MAC 514	3	
MAC 515	3	
MAC 516	3	

Master of Science in Sustainability Management

To earn an Master of Science in Sustainability Management, students must successfully complete 33 credit hours (11 courses). Full-time students are expected to enroll for at least three courses per semester and can complete their degree in two years. Part-time students can enroll for as few as one course per semester and can take up to five years to complete their degree. The program schedule allows flexibility to students who wish to accelerate their studies. For example, full-time students could graduate in roughly a year by starting in summer of year 1 and completing their program in summer of year 2, but this requires careful planning.

Curriculum

Required Courses			(24)
BUS 510	Building an Innovative and Sustainable Business		3
BUS 550	Business Analytics for Competitive Advantage		3
BUS 590	Business Innovation in the Next Economy		3
SMGT 501	Environmental Policy in a Competitive World		3
SMGT 502	Contemporary and Emerging Laws Governing the Environment		3
SMGT 503	Environmental Pollution Prevention and Control Strategies		3
SMGT 504	Industrial Ecology and Systems Thinking		3
SMGT 505	Environmental Finance		3
Elective Courses			(9)
Select a minimum of three courses from the following:			9
SMGT 511	Solid and Hazardous Waste Management and Remediation	3	
SMGT 512	Environmental Risk Assessment and Management	3	
SMGT 513	Environmental Economics and Climate Change	3	
SMGT 518	Ethics and Corporate Social Responsibility	3	
SMGT 525	Environmental Performance Analytics	3	
SMGT 529	Social Entrepreneurship	3	
SMGT 531	Environmental Advocacy	3	
SMGT 532	Environmental and Energy Law Clinic	3	
SMGT 541	Managing Energy Technologies	3	
SMGT 542	Economics of Energy Systems	3	
Total Credit Hours			33

Doctor of Philosophy in Management Science

Stuart's Ph.D. in Management Science offers comprehensive coverage on the application of quantitative methods, analytical tools, and computer models to decision-making problems in business, finance, and operations management.

Program Goals

This program prepares students and working professionals for careers in academia as well as executive and management positions in business, government, and consulting sectors. The Ph.D. program emphasizes both analysis and synthesis. The required courses provide the tools to analyze business problems and to develop new systems or new solutions. Once students master these skills, their dissertation work involves structuring a problem, gathering data where appropriate, and solving it. The research methodologies of management science can be applied to any aspect of business. The program's goal is to facilitate the contribution of new knowledge to the field of business through applied research that addresses important problems in operations and finance.

Admission Requirements

Applicants to the Ph.D. in Management Science must have a competitive score on the GMAT or GRE (316 or above for GRE and 650 or above for GMAT).

The following are additional requirements for each of the three tracks within the Ph.D. in Management Science:

1. M-track with Finance concentration: a graduate degree considered equivalent to the M.S. in Finance degree offered at the Stuart School
2. M-track with Analytics concentration: a graduate degree considered equivalent to the M.S. in Marketing Analytics degree offered at the Stuart School
3. UG-track with Finance or Analytics concentrations: an undergraduate degree with an outstanding record of academic accomplishments

Curriculum

Applicants to the Ph.D. program must have completed a master's degree with a graduate level business core, or a master's in finance or equivalent degree. For applicants who have a master's degree but have not completed the business core, some prerequisite courses will be required.

This program is selective and small with a high degree of interaction between faculty and students, and a mentor relationship with a faculty adviser. The Ph.D. committee carefully matches the interest of the student with the expertise of the faculty member. The program offers two concentrations: analytics and finance.

In order to earn a Ph.D. in Management Science, students are required to complete a total of 60 credit hours beyond the master's degree, with 24 credit hours devoted to dissertation research work. Students are required to complete twelve courses in the first two years, including eight Ph.D. core courses and four advanced elective courses in the chosen area of concentration (analytics or finance). In the third and fourth year of study, students enroll in four adviser-approved open electives, in addition to registering for dissertation credits to pursue and complete the doctoral dissertation.

Analytics Concentration

The Ph.D. program with a concentration in Analytics is well positioned in terms of opportunities for graduates in the career marketplace. Graduates can pursue career options ranging from traditional academia (teaching in schools offering programs focused on analytics) to positions in consulting, industry, and government that require expertise in business analytics, predictive modeling, and management of big data. The program offers opportunities to develop specialized skills involving analytics in fields such as marketing, networks, and supply chain management.

Finance Concentration

Graduates of the Ph.D. program with a concentration in Finance have a wide choice of careers. In addition to a traditional academic career focused on teaching and research, graduates may also work in investment and commercial banking, trading, and risk management. Dissertation research in this area may include a wide range of topics such as risk modeling, financial time series analysis, and investment analysis.

Doctor of Philosophy in Management Science - M-Track (for students with a prior master's degree)

In the first year, full-time students will complete the Ph.D. basic core (a six-course sequence of two courses each in economics, statistics, and optimization areas), before taking the qualifying exam. The qualifying exam must be taken after completing the six basic core courses, and the qualifying exam may only be taken once.

In the second year, full-time students will complete the Ph.D. advanced core (a six-course sequence consisting of two Ph.D. advanced core courses and four specialization-specific courses as shown below). After completing all required Ph.D. coursework, usually at the end of the second year of full-time study, a written comprehensive examination is required. This examination is a rigorous review of the level of competency achieved as a result of the entire program of graduate study. The comprehensive exam may be taken only twice.

In the third and fourth year of graduate study, students will take four adviser approved elective courses (or 12 credit hours) and enroll for 24 dissertation credit hours.

Basic Core Requirements		(18)
MSC 511	Economics I	3
MSC 512	Statistics I	3
MSC 513	Optimization I	3
MSC 514	Economics II	3
MSC 515	Statistics II	3
MSC 516	Optimization II	3
HUM 601	Teaching Assistant Seminar	0
Advanced Core Requirements		(18)
MSC 611	Philosophy of Management	3
MSC 612	Advanced Research Methods	3
Specialization courses (see Specializations tab for required courses)		12
Ph.D. Research		(24)
MSC 691	Research and Thesis PhD	24
Masters Transfer Credit		(12)
Credit allowance of 12 hours for prior master’s degree		12
Total Credit Hours		72

Doctor of Philosophy in Management Science - UG-Track (for students with an undergraduate degree only)

In the first year, full-time students will complete the Ph.D. basic core (a six-course sequence of two courses each in economics, statistics, and optimization areas) before taking the qualifying exam. The qualifying exam must be taken after completing the six basic core courses, and the qualifying exam may only be taken once.

In the second year, full-time students will complete the Ph.D. advanced core (a six-course sequence consisting of two Ph.D. advanced core courses and four specialization-specific courses as shown below). After completing all required Ph.D. coursework, usually at the end of the second year of full-time study, a written comprehensive examination is required. This examination is a rigorous review of the level of competency achieved as a result of the entire program of graduate study. The comprehensive exam may be taken only twice.

In the third and fourth year of graduate study, students will take four adviser approved elective courses (or 12 credit hours) and enroll for 24 dissertation credit hours.

Basic Core Requirements		(18)
MSC 511	Economics I	3
MSC 512	Statistics I	3
MSC 513	Optimization I	3
MSC 514	Economics II	3
MSC 515	Statistics II	3
MSC 516	Optimization II	3
HUM 601	Teaching Assistant Seminar	0
Advanced Core Requirements		(18)
MSC 611	Philosophy of Management	3
MSC 612	Advanced Research Methods	3
Specialization courses (see Specializations tab for required courses)		12
Ph.D. Research		(24)

MSC 691	Research and Thesis PhD	24
Elective Courses		(18)
Select 18 hours of adviser-approved elective courses		18
Total Credit Hours		78

Program of Study

Stuart requires that at least two semesters of study be completed on a full-time basis. The semesters need not be consecutive, but must occur within the six years prior to the awarding of the degree. After completion of coursework and qualifying/comprehensive exam requirements, the dissertation research may be done off campus if suitable arrangements for supervision are made.

When a student is ready to to begin dissertation research work, the Dean of the Stuart School will appoint a mutually acceptable research adviser to supervise the student's research. The student will work with the adviser to constitute a dissertation committee (composed of at least four full time faculty members including the adviser, one of whom will be a representative from outside the student's field) before beginning work on a dissertation project that must be an original investigation of high quality. Students are required to defend a dissertation proposal before the dissertation committee. After the dissertation project is completed, the student will appear before the dissertation committee to defend the dissertation project. Usually, the dissertation proposal defense and the dissertation defense are at least one year apart.

Students may take up to six years to complete the degree. After six years, students may petition for an extension, but they must reapply to the program and may be required to retake a comprehensive examination. A cumulative GPA of 3.0/4.0 in an approved program of study is a requirement for the Ph.D. program.

Students entering the program may transfer up to two courses from a graduate program at another AACSB-accredited university if the student has not used the courses to satisfy the requirements for a degree at the university. Additional courses may be transferred with the permission of the program director.

Some students may be required to take prerequisite courses in mathematics, statistics, or computer programming before being admitted to a graduate course. Undergraduate course offerings, which typically are listed with a primary numeral of four or below, cannot be used as free electives in the Ph.D. program.

Analytics Specialization

Required Courses		(12)
MSC 651	Quantitative Marketing Models	3
MSC 652	Supply Chain Analytics	3
MSC 653	Current Topics in Marketing Analytics	3
MSC 654	Social Network Analytics	3
Total Credit Hours		12

Finance Specialization

Required Courses		(12)
MSC 621	Corporate Finance	3
MSC 623	Investments	3
MSC 631	Theory of Finance I	3
MSC 633	Theory of Finance II	3
Total Credit Hours		12

Certificate in Corporate Finance (Post-Graduate)

Curriculum

Required Courses		(9)
MSF 534	Corporate Finance	3
MSF 535	Investment Banking	3
Select a minimum of one additional 500-level elective in finance		3
Total Credit Hours		9

Certificate in Economic Development and Social Entrepreneurship

Four graduate certificate programs are offered in public administration. These programs provide students with a post-baccalaureate knowledge of an area of specialization with public administration. Students in these programs register as certificate students. Certificate programs require a set of four courses. Students who are admitted to a master's degree program may apply coursework previously taken in a certificate program toward the requirements for the master's degree.

This certificate is designed for professionals who want to increase their knowledge and skills in economic development and social entrepreneurship but do not currently have the time to pursue a Master of Public Administration degree.

Curriculum

Core Course			(12)
PA 568	Strategic Competitiveness in the Public Sector		3
Select a minimum of three courses from the following:			9
PA 533	Advanced Financial Management for Public and Nonprofit Sectors	3	
PA 539	Local Government Management	3	
PA 550	Social Entrepreneurship	3	
PA 551	Public Infrastructure Management	3	
PA 555	Introduction to Urban and Regional Planning	3	
PA 556	Public Management Strategies for the 21st Century	3	
PA 570	Social Capital and the Community	3	
PA 578	Planning, Policy-Making, and the Built Environment	3	
Total Credit Hours			12

Additional courses could be taken in the Stuart sustainability management program, the Department of Civil, Architectural, and Environmental Engineering, and other related programs as permitted by program director.

Certificate in Entrepreneurial Finance

Curriculum

Required Courses			(9)
Select a minimum of 9 credit hours from the following:			9
MBA 576	Creating and Financing New Technology Ventures	3	
MSF 534	Corporate Finance	3	
MSF 535	Investment Banking	3	
MSF 595	Entrepreneurial Finance	3	
MSF 596	The Venture Capital Process	3	
Total Credit Hours			9

Certificate in Financial Economics (Post-Graduate)

Curriculum

Select a minimum of three courses from the following:			9
MSC 631	Theory of Finance I	3	
MSC 633	Theory of Finance II	3	
MSF 566	Time Series Analysis	3	
MSF 567	Bayesian Econometrics	3	
Total Credit Hours			9

Certificate in Financial Modeling (Post-Graduate)

Curriculum

Select a minimum of three courses from the following:			9
MSF 524	Models for Derivatives	3	
MSF 525	Term Structure Modeling and Interest Rate Derivatives	3	
MSF 575	C++ with Financial Markets	3	
MSF 576	OOP and Algorithmic Trading Systems	3	
MSF 577	High Frequency Finance	3	
Total Credit Hours			9

Certificate in Financial Toolbox

Curriculum

Required Courses		(9)
MSF 501	Mathematics with Financial Applications	3
MSF 502	Statistical Analysis in Financial Markets	3
MSF 503	Financial Modeling	3
Total Credit Hours		9

Certificate in Fundamentals of Finance

Curriculum

Required Courses		(9)
MSF 504	Valuation and Portfolio Management	3
MSF 505	Futures, Options, and OTC Derivatives	3
MSF 506	Financial Statement Analysis	3
Total Credit Hours		9

Certificate in Investments (Post-Graduate)

Curriculum

Select a minimum of three courses from the following:			9
MSF 545	Structured Fixed Income Portfolios	3	
MSF 546	Quantitative Investment Strategies	3	
MSF 549	Commodities and Managed Futures	3	
Total Credit Hours			9

Certificate in Nonprofit and Mission-Driven Management

Four graduate certificate programs are offered in public administration. These programs provide students with a post-baccalaureate knowledge of an area of specialization with public administration. Students in these programs register as certificate students. Certificate programs require a set of four courses. Students who are admitted to a master's degree program may apply coursework previously taken in a certificate program toward the requirements for the master's degree.

This certificate is designed for professionals who want to increase their knowledge and skills in nonprofit and mission-driven management but do not currently have the time to pursue a Master of Public Administration degree.

Curriculum

Core Course			(12)
PA 502	Leading and Managing Knowledge-Intensive Organizations		3
Select a minimum of three core courses from the following:			9
PA 505	The Law and the Nonprofit Sector	3	
PA 533	Advanced Financial Management for Public and Nonprofit Sectors	3	
PA 540	Alternative Dispute Resolution	3	
PA 541	Performance Measurement in Nonprofit and Public Management	3	
PA 543	Public Policy, Nonprofits, and Philanthropy	3	
PA 556	Public Management Strategies for the 21st Century	3	
PA 565	The Nonprofit Sector	3	
PA 566	Nonprofits and the Public Sector	3	
PA 570	Social Capital and the Community	3	
PA 579	Ethics and Professional Responsibility in Public Service	3	
Total Credit Hours			12

Certificate in Public Management

Four graduate certificate programs are offered in public administration. These programs provide students with a post-baccalaureate knowledge of an area of specialization with public administration. Students in these programs register as certificate students. Certificate programs require a set of four courses. Students who are admitted to a master's degree program may apply coursework previously taken in a certificate program toward the requirements for the master's degree.

This certificate is designed for professionals who want to increase their knowledge and skills in public management but do not currently have the time to pursue a Master of Public Administration degree.

Curriculum

Core Courses			(12)
Select a minimum of one course from the following:			3
PA 501	Essentials for Public Management in a Complex Society: Processes, Structures, and Values	3	
PA 502	Leading and Managing Knowledge-Intensive Organizations	3	
PA 532	Managing Public Financial Resources in a Changing World	3	
Select a minimum of three courses from the following:			9
PA 511	Comparative Public Administration	3	
PA 516	Information Technology in Public Administration	3	
PA 522	Effective Management of Human Resources in Environments of Scarce Resources	3	
PA 533	Advanced Financial Management for Public and Nonprofit Sectors	3	
PA 539	Local Government Management	3	
PA 540	Alternative Dispute Resolution	3	
PA 541	Performance Measurement in Nonprofit and Public Management	3	
PA 551	Public Infrastructure Management	3	
PA 556	Public Management Strategies for the 21st Century	3	
PA 562	Urban and Metropolitan Government	3	

PA 568	Strategic Competitiveness in the Public Sector	3	
PA 578	Planning, Policy-Making, and the Built Environment	3	
PA 579	Ethics and Professional Responsibility in Public Service	3	
PA 580	Policy Evaluation Analytics	3	
Total Credit Hours			12

Certificate in Risk Management (Post-Graduate)

Curriculum

Required Courses		(9)
MSC 622	Enterprise Risk Management	3
MSF 554	Market Risk Management	3
MSF 555	Credit Risk Management	3
Total Credit Hours		9

Certificate in Security, Safety, and Risk Management

Four graduate certificate programs are offered in public administration. These programs provide students with a post-baccalaureate knowledge of an area of specialization with public administration. Students in these programs register as certificate students. Certificate programs require a set of four courses. Students who are admitted to a master's degree program may apply coursework previously taken in a certificate program toward the requirements for the master's degree.

This certificate is designed for professionals who want to increase their knowledge and skills in security, safety, and risk management but do not currently have the time to pursue a Master of Public Administration degree.

Curriculum

Core Courses			(12)
PA 502	Leading and Managing Knowledge-Intensive Organizations		3
Select a minimum of three courses from the following:			9
PA 536	Strategy and Structure: Homeland Security	3	
PA 537	Crisis Management and Homeland Security	3	
PA 538	Information Systems Security and Cyber Crime	3	
PA 539	Local Government Management	3	
PA 553	Public Safety Administration	3	
PA 556	Public Management Strategies for the 21st Century	3	
PA 579	Ethics and Professional Responsibility in Public Service	3	
PA 588	Incident Response, Disaster Recovery, and Business Continuity	3	
Total Credit Hours			12

Certificate in Trading (Post-Graduate)

Curriculum

Select a minimum of three courses from the following:			9
MSF 576	OOP and Algorithmic Trading Systems	3	
MSF 577	High Frequency Finance	3	
MSF 584	Equity and Equity Derivatives Trading	3	
MSF 585	Foreign Exchange Market and Fixed Income Strategies	3	
Total Credit Hours			9

Interdisciplinary Education

Energy/Environment/Economics (E3)

Faculty Directors

Chemical and Environmental Engineering

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Mechanical, Materials and Aerospace Engineering

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The ongoing evolution of the energy system and related global, environmental, and economic issues make necessary a new interdisciplinary approach to the education of energy-industry engineers and management professionals, as well as to the planning and performance of energy research and development. The petroleum, coal, natural gas, nuclear, renewable, and electric utility industries and associated resource and raw material extraction, equipment design and manufacturing, and construction industries, are facing not only technological change and environmental constraints, but also drastic changes in the economic, institutional, and trade environments in which they operate.

The university's Energy/Environment/Economics (E^3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

The E^3 specialization requires an interdisciplinary thesis in an E^3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E^3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E^3 is designed primarily for students majoring in chemical and environmental, mechanical and aerospace, or electrical engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, environmental issues related to energy extraction, conversion and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices.

Research Centers, Facilities, and Areas

Students should consult descriptions in the respective departments:

- Chemical and Biological Engineering (p. 46)
- Electrical and Computer Engineering (p. 95)
- Mechanical, Materials, and Aerospace Engineering (p. 143)

General Degree Requirements

Students pursuing a master's degree are required to take 30-32 credit hours beyond the requirements of a B.S. degree program. The Ph.D. program requires 84 credit hours beyond the bachelor of science. The curriculum consists of two components: department core courses that provide a strong background in basic principles of the chosen engineering field and E^3 specialization courses. The following section details the E^3 course requirements for M.S., professional master's, and Ph.D. degrees in chemical engineering, environmental engineering, mechanical and aerospace engineering, and electrical engineering. Selected E^3 undergraduate courses may be substituted for graduate courses with the approval of the designated adviser, if the total undergraduate credit hours for the professional master's or M.S. degree do not exceed departmental constraints.

Students are also required to attend interdisciplinary seminars during their first and/or second semesters, which are offered as part of the regular graduate seminars by the Department of Chemical and Biological Engineering; the Department of Mechanical, Materials, and Aerospace Engineering; and Department of Electrical and Computer Engineering. A student completing a M.S. or Ph.D. thesis or professional master's project will be a member of an interdisciplinary research team consisting of professors and students from chemical, environmental, electrical, and mechanical engineering backgrounds, working in a cross-disciplinary group project. Each interdisciplinary team must include professors from different departments.

Policies and procedures regarding admission, advising, financial aid, and comprehensive examinations are established by the individual departments offering this program.

Admission Requirements

Students should consult listings in the respective departments:

- Chemical and Biological Engineering (p. 46)
- Electrical and Computer Engineering (p. 95)
- Mechanical, Materials, and Aerospace Engineering (p. 143)

Degrees Offered

Professional Master's/Master of Engineering

- Master of Chemical Engineering with E3 Specialization (p. 459)
- Master of Electrical and Computer Engineering with E3 Specialization (p. 459)
- Master of Engineering in Environmental Engineering with E3 Specialization (p. 460)
- Master of Engineering in Materials Science and Engineering with E3 Specialization (p. 461)
- Master of Engineering in Mechanical and Aerospace Engineering with E3 Specialization (p. 462)

Master of Science

- M.S. in Chemical Engineering with E3 Specialization (p. 463)
- M.S. in Electrical Engineering with E3 Specialization (p. 463)
- M.S. in Environmental Engineering with E3 Specialization (p. 466)
- M.S. in Materials Science and Engineering with E3 Specialization (p. 466)
- M.S. in Mechanical and Aerospace Engineering with E3 Specialization (p. 467)

Doctor of Philosophy

- Ph.D. in Chemical Engineering with E3 Specialization (p. 468)
- Ph.D. in Electrical Engineering with E3 Specialization (p. 468)
- Ph.D. in Environmental Engineering with E3 Specialization (p. 469)
- Ph.D. in Mechanical and Aerospace Engineering with E3 Specialization (p. 469)

E3 Courses

See descriptions under the respective department's course listings.

Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

Code	Title	Credit Hours
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3

Master of Chemical Engineering with Specialization in Energy/Environment/Economics (E3)

This program has the same requirements as the M.S. degree program, except that in place of 6-8 credit hours of M.S. thesis research, students are required to register for 2-5 credit hours of special projects research (CHE 594), plus additional E3 courses with the approval of their adviser. Students are also encouraged to register or attend the interdisciplinary graduate seminar (CHE 593) or general seminars offered in energy and/or sustainability areas by the Wanger Institute for Sustainable Energy Research (WISER).

Curriculum

Code	Title	Credit Hours
Core Courses		(12)
CHE 525	Chemical Reaction Engineering	3
CHE 535	Applications of Mathematics to Chemical Engineering	3
CHE 551	Advanced Transport Phenomena	3
CHE 553	Advanced Thermodynamics	3
Special Projects Research		(2-5)
CHE 594	Special Projects	2-5
E3 Courses		(9)
CHE 543	Energy, Environment, and Economics	3
Select a minimum of one course from Group A		3
Select a minimum of one course from Group B		3
Electives		(5-8)
Select 5 to 8 credit hours		5-8
Recommended		(1)
CHE 593	Seminar in Chemical Engineering (or general seminars offerend in energy and/or sustainability by WISER)	1

Minimum degree credits required: 32

Master of Electrical and Computer Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum 700-Level Credit	6
Minimum ECE Credit	24
Maximum Transfer Credit	9

Code	Title		Credit Hours
E3 Courses			(12)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of two courses from Group A			6
Select a minimum of one course from Group B			3
Power & Control Courses			(6-8)
Select a minimum of two courses from the following:			6-8
ECE 411	Power Electronics	4	
ECE 412	Electric Motor Drives	4	
ECE 417	Power Distribution Engineering	3	
ECE 419	Power Systems Analysis with Laboratory	4	
ECE 420	Analytical Methods in Power Systems	3	

ECE 438	Control Systems	3
ECE 505	Applied Optimization for Engineers	3
ECE 506	Analysis of Nonlinear Systems	3
ECE 531	Linear System Theory	3
ECE 535	Discrete Time Systems	3
ECE 538	Renewable Energies	3
ECE 539	Computer Aided Design of Electric Machines	3
ECE 540	Reliability Theory and System Implementation	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Systems Dynamics	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Market Economics and Security	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3
Master's Project		(3-6)
Select 3-6 credit hours [1]		3-6
General Electives		(6-11)
Select 6-11 credit hours of electives from ECE 400-599, ECE 601-699, and ECE 700-799		6-11

1 ECE 594 or ECE 597

Master of Engineering in Environmental Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title	Credit Hours
Core Courses		(24)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
Select one E3 course from Group A		3
Select two E3 courses from Group B [1]		6
Special Project Research		(2-5)
ENVE 597	Special Problems	2-5
Additional E3 Courses		(3-6)

Select 3-6 credit hours with the approval of adviser	3-6

Minimum degree credits required: 32

[1] In addition to the listed E3 Group B course options, Master of Engineering in Environmental Engineering students may select EMS 504 and CAE 589 as Group B course options.

Master of Engineering in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title		Credit Hours
Core Courses			(15)
CHE 543	Energy, Environment, and Economics		3
MMAE 468	Introduction to Ceramic Materials		3
MMAE 569	Advanced Physical Metallurgy		3
Select a minimum of one course from the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE 566	Electrochemical Engineering	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 470	Introduction to Polymer Science	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	
MMAE 579	Advanced Materials Processing	3	
Select a minimum of one course from the following:			3
CHE 567	Fuel Cell Fundamentals	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Electives			(6)
Select a minimum of 6 hours of elective courses			6
Total Credit Hours			30

Master of Engineering in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title		Credit Hours
Engineering Analysis Courses			(6)
MMAE 501	Engineering Analysis I		3
MMAE 502	Engineering Analysis II		3
Core Courses			(9)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of one course from the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
MMAE 524	Fundamentals of Combustion	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 524	Fundamentals of Combustion	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 526	Heat Transfer: Conduction	3	
MMAE 527	Heat Transfer: Convection and Radiation	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE/MMAE 560	Statistical Quality and Process Control	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Electives			(6)
Select 6 credit hours			6
Total Credit Hours			30

Master of Science in Chemical Engineering with Specialization in Energy/Environment/Economics (E3)

Students pursuing the M.S. in Chemical Engineering with E3 specialization are required to take CHE 543 and select at least one course from Group A and one course from Group B, and register for 6-8 credit hours of M.S. thesis preparation (CHE 591) in an interdisciplinary E3 area. In addition, the students are required to take all required core courses for the M.S. in Chemical Engineering degree.

Students may apply up to 12 credit hours of 400-level courses to the M.S. degree requirements with their adviser's approval. Students are also encouraged to register or attend the interdisciplinary graduate seminar (CHE 593) or general seminars offered in energy and/or sustainability areas by the Wanger Institute for Sustainable Energy Research (WISER).

Curriculum

Code	Title	Credit Hours
Core Courses		(12)
CHE 525	Chemical Reaction Engineering [1]	3
CHE 535	Applications of Mathematics to Chemical Engineering [1]	3
CHE 551	Advanced Transport Phenomena [1]	3
CHE 553	Advanced Thermodynamics [1]	3
E3 Courses		(9)
CHE 543	Energy, Environment, and Economics	3
Select one course from Group A		3
Select one course from Group B		3
Thesis Research		(6-8)
CHE 591	Research and Thesis for M.S. Degree	6-8
Electives		(2-4)
Select 2 to 4 credit hours		2-4
Recommended		(1)
CHE 593	Seminar in Chemical Engineering (or general seminars offered in energy and/or sustainability by WISER)	1
	Minimum degree credits required:	**32**

1 A minimum grade point average of 3.0/4.0 is required for core courses.

Master of Science in Electrical Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Code	Title		Credit Hours
E3 Courses			(12)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of two courses from Group A			6
Select a minimum of one course from Group B			3
Power & Control Courses			(6-8)
Select a minimum of two courses from the following:			6-8
ECE 411	Power Electronics	4	
ECE 412	Electric Motor Drives	4	

ECE 417	Power Distribution Engineering	3	
ECE 419	Power Systems Analysis with Laboratory	4	
ECE 420	Analytical Methods in Power Systems	3	
ECE 438	Control Systems	3	
ECE 505	Applied Optimization for Engineers	3	
ECE 506	Analysis of Nonlinear Systems	3	
ECE 531	Linear System Theory	3	
ECE 535	Discrete Time Systems	3	
ECE 538	Renewable Energies	3	
ECE 539	Computer Aided Design of Electric Machines	3	
ECE 540	Reliability Theory and System Implementation	3	
ECE 548	Energy Harvesting	3	
ECE 549	Motion Control Systems Dynamics	3	
ECE 550	Power Electronic Dynamics and Control	3	
ECE 551	Advanced Power Electronics	3	
ECE 552	Adjustable Speed Drives	3	
ECE 553	Power System Planning	3	
ECE 554	Power System Relaying	3	
ECE 555	Power Market Operations	3	
ECE 556	Power Market Economics and Security	3	
ECE 557	Fault-Tolerant Power Systems	3	
ECE 558	Power System Reliability	3	
ECE 559	High Voltage Power Transmission	3	
ECE 560	Power Systems Dynamics and Stability	3	
ECE 561	Deregulated Power Systems	3	
ECE 562	Power System Transaction Management	3	
ECE 563	Computational Intelligence in Engineering	3	
ECE 564	Control and Operation of Electric Power Systems	3	
ECE 580	Elements of Sustainable Energy	3	
ECE 581	Elements of Smart Grid	3	
ECE 582	Microgrid Design and Operation	3	
Communications & Signal Processing			(3-4)
Select a minimum of one course from the following:			3-4
ECE 401	Communication Electronics	3	
ECE 403	Digital and Data Communication Systems	3	
ECE 405	Digital and Data Communication Systems with Laboratory	4	
ECE 421	Microwave Circuits and Systems	3	
ECE 423	Microwave Circuits and Systems with Laboratory	4	
ECE 436	Digital Signal Processing I with Laboratory	4	
ECE 437	Digital Signal Processing I	3	
ECE 481	Image Processing	3	
ECE 504	Wireless Communication System Design	3	
ECE 507	Imaging Theory & Applications	3	
ECE 508	Video Communications	3	
ECE 509	Electromagnetic Field Theory	3	
ECE 511	Analysis of Random Signals	3	
ECE 513	Communication Engineering Fundamentals	3	
ECE 514	Digital Communication Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 516	Coding for Distributed Storage Systems	3	
ECE 519	Coding for Reliable Communications	3	
ECE 522	Electromagnetic Compatibility	3	

ECE 565	Computer Vision and Image Processing	3	
ECE 566	Statistical Pattern Recognition	3	
ECE 567	Statistical Signal Processing	3	
ECE 568	Digital Speech Processing	3	
ECE 569	Digital Signal Processing II	3	
ECE 570	Fiber-Optic Communication Systems	3	
ECE 576	Antenna Theory	3	
ECE 578	Microwave Theory	3	
Computer & Microelectronics			(3-4)
Select a minimum of one course from the following:			3-4
ECE 407	Introduction to Computer Networks with Laboratory	4	
ECE 408	Introduction to Computer Networks	3	
ECE 425	Analysis and Design of Integrated Circuits	3	
ECE 429	Introduction to VLSI Design	4	
ECE 441	Microcomputers	4	
ECE 443	Introduction to Computer Security	4	
ECE 446	Advanced Logic Design	4	
ECE 449	Object-Oriented Programming and Computer Simulation	3	
ECE 485	Computer Organization and Design	3	
ECE 502	Basic Network Theory	3	
ECE 521	Quantum Electronics	3	
ECE 524	Advanced Electronic Circuit Design	3	
ECE 525	RF Integrated Circuit Design	3	
ECE 526	Active Filter Design	3	
ECE 527	Performance Analysis of RF Integrated Circuits	3	
ECE 529	Advanced VLSI Systems Design	3	
ECE 530	High Performance VLSI IC Systems	3	
ECE 541	Performance Evaluation of Computer Networks	3	
ECE 542	Design and Optimization of Computer Networks	3	
ECE 543	Computer Network Security	3	
ECE 544	Wireless and Mobile Networks	3	
ECE 545	Advanced Computer Networks	3	
ECE 546	Wireless Network Security	3	
ECE 547	Wireless Networks Performance Analysis	3	
ECE 571	Nanodevices and Technology	3	
ECE 575	Electron Devices	3	
ECE 583	High Speed Computer Arithmetic	3	
ECE 584	VLSI Architecture for Signal Processing and Communication Systems	3	
ECE 585	Advanced Computer Architecture	3	
ECE 586	Fault Detection in Digital Circuits	3	
ECE 587	Hardware/Software Codesign	3	
ECE 588	CAD Techniques for VLSI Design	3	
ECE 589	Computer-Aided Design of Analog IC	3	
Master's Thesis Research			(6-8)
ECE 591	Research and Thesis for Masters Degree [1]		6-8
General Electives			(0-2)
Select 0-2 credit hours of ECE 400-599, ECE 600-699, and ECE 700-799 [2]			0-2

[1] Thesis research topic must be in an interdisciplinary E3 area.

[2] Students should choose one advanced math course if that requirement was not met in the B.S. degree.

Master of Science in Environmental Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title	Credit Hours
Core Courses		(24)
CAE 523	Statistical Analysis of Engineering Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 580	Hazardous Waste Engineering	3
Select one E3 course from Group A		3
Select two E3 courses from Group B [1]		6
Elective Courses		(0-2)
Select 0-2 credit hours		0-2
Thesis Research		(6-8)
ENVE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

1 In addition to the listed E3 Group B course options, Master of Science in Environmental Engineering students may select EMS 504 and CAE 589 as Group B course options.

Students may apply up to two 400-level courses to the M.S. degree requirements with their adviser's approval.

Master of Science in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title		Credit Hours
Core Courses			(15)
CHE 543	Energy, Environment, and Economics		3
MMAE 468	Introduction to Ceramic Materials		3
MMAE 569	Advanced Physical Metallurgy		3
Select one of the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE 566	Electrochemical Engineering	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 470	Introduction to Polymer Science	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 561	Solidification and Crystal Growth	3	
MMAE 563	Advanced Mechanical Metallurgy	3	
MMAE 566	Problems in High-Temperature Materials	3	
MMAE 571	Miscrostructural Characterization of Materials	3	
MMAE 573	Transmission Electron Microscopy	3	

MMAE 579	Advanced Materials Processing	3	
Select a minimum of one course from the following:			3
CHE 567	Fuel Cell Fundamentals	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	
ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8
Electives			(0-2)
Select elective courses as needed			0-2

Minimum degree credits required: 32

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3)

Curriculum

Code	Title		Credit Hours
Engineering Analysis Courses			(6)
MMAE 501	Engineering Analysis I		3
MMAE 502	Engineering Analysis II		3
Core Courses			(9)
CHE 543	Energy, Environment, and Economics		3
Select a minimum of one course from the following:			3
CHE 503	Thermodynamics	3	
CHE 553	Advanced Thermodynamics	3	
MMAE 520	Advanced Thermodynamics	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3	
MMAE 523	Fundamentals of Power Generation	3	
MMAE 524	Fundamentals of Combustion	3	
Non-Core Courses			(9)
Select a minimum of two courses from the following:			6
MMAE 524	Fundamentals of Combustion	3	
MMAE 525	Fundamentals of Heat Transfer	3	
MMAE 526	Heat Transfer: Conduction	3	
MMAE 527	Heat Transfer: Convection and Radiation	3	
Select a minimum of one course from the following:			3
CHE 541	Renewable Energy Technologies	3	
CHE/MMAE 560	Statistical Quality and Process Control	3	
ENVE 501	Environmental Chemistry	3	
ENVE 506	Chemodynamics	3	
ENVE 542	Physiochemical Processes in Environmental Engineering	3	
ENVE 551	Industrial Waste Treatment	3	
ENVE 561	Design of Environmental Engineering Processes	3	

ENVE 570	Air Pollution Meteorology	3	
ENVE 577	Design of Air Pollution Control Devices	3	
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3	
ENVE 580	Hazardous Waste Engineering	3	
Thesis Research			(6-8)
MMAE 591	Research and Thesis M.S.		6-8
Electives			(0-2)
Select elective courses as needed			0-2

Minimum degree credits required: 32

Doctor of Philosophy with Specialization in Energy/Environment/Economics (E3)

Curriculum

Students interested in the Ph.D. program in all disciplines (chemical; environmental; mechanical, materials, and aerospace; and electrical engineering) are required to take at least 72 credit hours beyond the B.S. degree requirements, including CHE 543, and at least five E^3 courses (four from both groups A and B; see course listings below) upon the recommendation of their thesis adviser. Registration for approximately 24 credit hours of Ph.D. thesis research in E^3 areas of study is also required. Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E^3 students must include at least one E^3 professor from outside the student's department.

Doctor of Philosophy in Chemical Engineering with E3 Specialization Curriculum

Code	Title	Credit Hours
Core Courses		(33)
CHE 525	Chemical Reaction Engineering	3
CHE 530	Advanced Process Control	3
or CHE 536	Computational Techniques in Engineering	
CHE 535	Applications of Mathematics to Chemical Engineering	3
CHE 551	Advanced Transport Phenomena	3
CHE 553	Advanced Thermodynamics	3
CHE 543	Energy, Environment, and Economics	3
Select 5 E3 courses from Groups A and/or B		15
Ph.D. Research		(24)
Register for 24 hours of Ph.D. thesis research in E3 areas of study		24

Minimum degree credits required: 72

Doctor of Philosophy in Electrical Engineering with E3 Specialization Curriculum

Requirement	Credits
Minimum Credits Required	72
Minimum 500+-level ECE Course Credits	15
Maximum Transfer Credit	32

Code	Title	Credit Hours
E3 Courses		(18)
CHE 543	Energy, Environment, and Economics	3
Select a minimum of five courses from Groups A and B		15
Ph.D. Research		(24-36)
ECE 691	Research and Thesis for Ph.D. [1]	24-36

[1] Dissertation research topic must be in an interdisciplinary E3 area.

Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one professor with specialization in an energy and sustainability area from outside the student's department.

Doctor of Philosophy in Environmental Engineering with E3 Specialization Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CHE 543	Energy, Environment, and Economics	3
Select 5 E3 courses from Groups A and/or B [1]		15
Ph.D. Research		(24)
ENVE 691	Research and Thesis Ph.D.	24

Minimum degree credits required: 84

[1] In addition to the listed E3 Group B course options, Ph.D. in Environmental Engineering students may select EMS 504 and CAE 589 as Group B course options.

Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one E3 professor from outside the student's department.

Doctor of Philosophy in Mechanical and Aerospace Engineering with E3 Specialization Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CHE 543	Energy, Environment, and Economics	3
Select 5 E3 courses from Groups A and/or B		15
Ph.D. Research		(24)
MMAE 691	Research and Thesis Ph.D.	24

Minimum degree credits required: 72

Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E3 students must include at least one E3 professor from outside the student's department.

Intellectual Property Management and Markets

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Knowledge and other intellectual assets are increasingly recognized as a driving force of innovation and economic growth. Intellectual property rights are becoming central to the modern economy. Illinois Institute of Technology's Master of Intellectual Property Management and Markets program (IPMM) was developed to respond to the need for highly qualified professionals for this important and fast-growing area.

The IPMM program provides a foundational understanding of intellectual property that integrates the perspectives and skills of five key disciplines: business, law, engineering, design, and computer science. Courses track the lifecycle of intellectual property from its inception to full exploitation. Graduates of this program will be equipped to take a strategic or leadership role leveraging and managing IP, whether through marketing, research and development, portfolio management, legal protection, or business transactions.

Degree Offered

- Master of Intellectual Property Management and Markets (p. 473)

Course Descriptions

IPMM 500
Context/Introduction and Protecting IP
This introduction will address the relatively unique nature of intangible property and the key ways it differs from "brick and mortar" assets. Some historical background on property structures will be covered. The rapid growth of patent, trademark and copyright protection and their importance to the global economy will be explored. Case studies that will be used throughout the program will be introduced. Integrated into the introduction is a survey course that will compare and contrast the four intellectual property regimes -- patent, trade secret, trademark and copyright -- in the context of their application to business. Topics to be explored include the point at which protection arises, the scope of protection available and the basis for enforcement actions. National and international considerations will be covered. The class will work in teams to identify and define protectable IP.
Lecture: 4 **Lab:** 0 **Credits:** 4

IPMM 501
Managing the Creative Process
This course teaches two approaches for innovation: top down and bottom up. The first part of the class will focus on top down innovation, specifically looking at innovation with a corporate, strategic lens. This section will include topics such as patterns of innovation, dominant design, various innovation strategies, as well as organizing for innovation. The second part of the class will focus on bottom up innovation, focused primarily on an approach for developing innovative, user-centered products and services. Students will learn methods for identifying unmet needs and generating new ideas. The intention is to teach students the why (from a corporate point of view, why is innovation critical?) and the how (from a project point of view, how do we create innovations?) of innovation.
Lecture: 3 **Lab:** 0 **Credits:** 3

IPMM 502
IAM Methodologies and IP Assessment
This course provides students with the fundamental structures for good intellectual asset management and with examples of the variety of ways in which those structures are implemented in businesses. Core to this study are the variety of techniques for conducting assessments of IP in the marketplace, in the competition, and within the business to determine strengths and vulnerabilities. Students also learn how to determine what IP the organization might need to meet its business strategies, what supporting products and services exist to assist in the management and assessment of IP. The course focuses on the legal, business and technical pros and cons of internal development of IP in the context of the marketplace and the business landscape.
Lecture: 3 **Lab:** 0 **Credits:** 3

IPMM 503
Acquiring IP
An in-depth examination of the ways IP may be acquired other than through creation. Topics include: asset purchase; business transactions such as joint ventures and joint development; strategic alliances; licenses; mergers and acquisitions; and patent pooling. Emerging issues such as open sourcing and open innovation will be explored. Antitrust implications of these various business transactions will be covered from a business perspective.
Lecture: 3 **Lab:** 0 **Credits:** 3

IPMM 504
IP and Business Strategy
Business Strategy is about creatively deploying organizational resources, including intellectual property, in order to create a sustainable competitive advantage for the company. In turn, sustainable competitive advantage is the key to long-term profitability of the company. In this course, students will learn about the various tools, concepts and theories of strategy development and execution. In particular, the focus is on the deployment of IP in innovative business strategies that ultimately drive competitive advantage and profitability. From a theoretical standpoint, the discussion will largely revolve around corporate and business unit strategy, aided by interesting case studies that show the use of intellectual property by companies generating competitive advantage. This discussion is supplemented by a computer simulation game called the Blue Ocean Strategy Simulation (BOSS) which helps student understand the process of developing innovative business strategies and implementing them in practice. The total combination of lectures, case studies and the simulation will result in a rich and exciting learning experience for students.
Lecture: 3 **Lab:** 0 **Credits:** 3

IPMM 505
Global IP Management
This is a broad course covering the critical areas of IP portfolio management in a variety of business settings. The course focuses on the role of innovation and intellectual property within the global operation of companies and addresses strategies for global IP coverage, including decisions on when, where and how to seek IP protection on a cost-effective basis. This course will also teach principles of IT portfolio management that affect the operations, planning, knowledge management, and new product/ process development of businesses trading internationally. Various scenarios and cases will be discussed, such as technological discontinuities, mergers, divestitures, regulations, nationalization of corporate assets, and reorganizations.
Lecture: 3 **Lab:** 0 **Credits:** 3

IPMM 506
Maximizing IP Value
This is an examination of the methods used to value IP in various settings: IP owned by a business; IP which is the target of acquisition; and IP which has been asserted against a business by a third party IP owner. All of the methods examined will be anchored in a review of applicable regulations and accounting principles. Other topics covered are: securitization and/or monetization of IP with particular focus on IP holding companies and their benefits, liabilities, and challenges; issues of taxation with particular focus on tax efficient means of optimizing IP value; and deployment of and defense against the adversarial assertion of IP by non-practicing entities (also known as "patent trolls").
Lecture: 3 **Lab:** 0 **Credits:** 3

IPMM 507
Capstone
This course will provide an experiential learning opportunity which brings together and applies the new knowledge, experiences, and expertise derived from the doctrinal classes. Working in teams, students will create an intellectual property strategy and plan for a business or institution which is currently underutilizing its IP assets or facing IP challenges from third parties or competitors. Each team will prepare a written and oral presentation to a panel of experts representing senior management of the business studied.
Lecture: 2 **Lab:** 0 **Credits:** 2

IPMM 508
Patent Analytics and Landscape Reports for Supporting Organizational Decision Making
This course provides details on the stages required for performing patent analytics and for the preparation of a patent landscape report (PLR). Patent analytics and PLRs support informed decision making and are designed to efficiently address the concerns associated with making high-stakes decisions in technologically advanced areas with a maximum degree of confidence.
Lecture: 3 **Lab:** 0 **Credits:** 3

Master of Intellectual Property Management and Markets

Curriculum

30 credit hours

No thesis is required, but there is a capstone/project course requirement (2 credit hours). This course is an experiential learning opportunity that integrates the students' newly acquired knowledge, experiences, and expertise. Students will create a global intellectual property strategy and plan for a company.

ACADEMIC POLICIES AND PROCEDURES

Academic Honesty

Illinois Institute of Technology expects students to maintain high standards of academic integrity. Students preparing for the practice of a profession are expected to conform to a code of integrity and ethical standards commensurate with the high expectations that society places upon the practitioners of a learned profession. No student may seek to gain an unfair advantage over another. It shall be a violation of this code for students to engage in conduct that violates the standards of their major academic discipline, the standards of the academic discipline in which they are engaged, the standards of a profession in which they are training, or the standards of the university set forth here. It is a violation for a matriculated or non-matriculated student, whether or not currently enrolled in the university, to knowingly engage or attempt to engage in:

1. Misrepresenting any work submitted for credit as the product of a student's sole independent effort, such as using the ideas of others without attribution and other forms of plagiarism.
2. The use of sources beyond those authorized by the instructor in any work submitted for credit.
3. The use of any unauthorized assistance in taking quizzes, tests, or examinations.
4. The acquisition, without permission, of tests, answer sheets, problem solutions or other academic material when such material has been withheld from distribution by the instructor.
5. Failure to abide by the instructions of an instructor or exam-proctor.
6. Deliberate and harmful obstruction of the studies, research, or academic work of any member of the Illinois Institute of Technology community.
7. Making material misrepresentation in any submission to or through any office of Illinois Institute of Technology to a potential employer, professional society, meeting, or organization.
8. The intentional assistance of others in the violation of the standards set forth in this Code.

Refer to the Graduate Student Handbook for specific details regarding disciplinary action and appeal procedures.

Note: Students in the Chicago-Kent College of Law are subject to the Chicago-Kent College of Law Code of Conduct.

Advising and Academic Progress

Academic Probation

A student whose cumulative GPA falls below 3.0/4.0 is no longer in good standing and must petition the Office of Graduate Academic Affairs for permission for provisional enrollment by submitting Form G702 Graduate Probation Contract. Students for whom provisional enrollment is granted must not earn a semester GPA less than 3.0 while on academic probation. Probationary students who receive "C" or "E" grades will be required to repeat courses, subject to the limits specified within this bulletin, to improve the cumulative and/or program GPA. Registration is restricted to nine credit hours during the probationary period, until the student is returned to good academic standing.

Dismissal will occur when a student fails to make the requisite academic progress during the probationary period. Students may not register for a co-op while on academic probation. If a student's GPA in his or her approved program of study is below 3.0, then graduate courses approved on an updated Plan of Study may be added to the program until the corresponding GPA is at least 3.0, with the approval of the academic adviser, unit or department, and the Office of Graduate Academic Affairs.

Grade Point Average

Satisfactory performance for graduate study is defined as the maintenance of a minimum cumulative GPA of 3.0/4.0, as reported by the Office of the Registrar. However, only the grades for those courses which appear in the student's Graduate Degree Works Audit form that fulfill the degree program requirements and on the approved Plan of Study are used in the calculation of the GPA for graduation. There is no exception or waiver to this rule. If a student repeats a course, the last grade issued for the course will be used to compute the cumulative GPA and the Plan of Study GPA. Students should consult the section on Repeating a Course (p. 481) within the Graduate Bulletin for course repeat limitations.

Change of Master's Thesis to Non-Thesis

In several majors, a master's degree may be earned without the preparation of a thesis. When changing from a thesis to non-thesis option, a student may transfer up to four hours of credit for satisfactorily completed Course 591 (Research and Thesis for the Master's Degree) to satisfy the requirement for Course 594 (Special Projects), provided that two conditions are met: first, the student's GPA must be at least 3.0/4.0; second, the student's academic unit must permit the change to a non-thesis option after consulting with the student's adviser and must approve the transfer on the grounds that the thesis-oriented work is equivalent to work on a project. Procedures for evaluating the transfer of credits from 591 and 691 to 594 (and for evaluating the student's performance on the Special Project) must be documented and monitored by each academic unit. The Graduate College will allow up to four credit hours of 591 or 691 to be converted to 594 credits. Form G701 Graduate Student Petition is used to request this conversion.

To initiate a request to change from thesis to a non-thesis option, the student will complete a change of thesis option using eForms for Graduate Degree Works, which is accessed from the MyIIT portal (my.iit.edu) under the Academics tab.

More information regarding the use of 591 and 691 credit is available in the Research Credit Use section (p. 475) of the Graduate Bulletin.

Course Substitutions

A course exception or substitution is requested using eForms in Graduate Degree Works, which is accessed from the MyIIT portal (my.iit.edu) under the Academics tab. The Office of Graduate Academic Affairs may not approve changes in the program after the student has filed an application for graduation without the prior approval of both the academic adviser and the department approver. Once a course on the student's approved plan of study has been completed (i.e., grades have been issued), it may not be dropped to raise the program GPA required for graduation. A new plan of study is required when a student requests and receives approval of a change of program (degree, major, specialization or concentration, thesis or non-thesis option) or when admitted to a new degree program. This plan is filed in Graduate Degree Works using the Plans tab.

Credit by Proficiency Examination

With the prior approval of their respective advisers, academic unit heads, and the Associate Dean of the Graduate College, students may obtain credit for a course by paying the published fee and taking a special examination. Credit by examination is limited to nine credit hours with grades of "A" or "B" and is subject to the limitations for transfer credit in a degree program. Special exams are not permitted for courses in which the student has previously enrolled or for topics in which the student has never taken a course. Students need to be registered in a semester in which a special examination is taken. The Credit by Proficiency Examination Form is submitted to initiate this request.

Plan of Study and Degree Program Requirements

A graduate degree will be awarded upon the completion of a coherent program of study. Degree program requirements are compared with the student's approved plan of study, which may include pre-approved course exceptions.

Filing of the Plan of Study in Graduate Degree Works is the mechanism for outlining and obtaining approval of a coherent program and may be accessed and submitted online in the MyIIT portal (my.iit.edu) under the Academics tab. Master's and doctoral students must file a plan of study before completing nine credit hours of graduate study; however, doctoral students without a prior master's degree will file a plan of study before completing 18 credit hours. After these deadlines, further registration may not be allowed until a plan of study is approved by the Office of Graduate Academic Affairs. A degree-seeking graduate student will be assigned to a preliminary adviser when admitted. An academic adviser will be officially assigned, by the academic unit or department, before the student's plan of study can be submitted and approved. The student may subsequently request a change of adviser by selection of the option in eForms for Graduate Degree Works.

Courses that appear in the fallthrough section of the Graduate Degree Works Worksheet may be considered, on an exceptional basis, by selection of the transfer credit and course substitution and exception option in eForms for Graduate Degree Works. Exception approval is granted at the discretion of the academic adviser, unit or department approver, and the Office of Graduate Academic Affairs.

Courses that appear in the insufficient section of the Graduate Degree Works Worksheet are not applicable to fulfill degree credit hour requirements, and failed course grades will impact the student's cumulative and program grade point averages. Reconciliation of the program grade point average is completed in the semester of application for degree conferral (graduation).

A course with a failed grade that appears on the approved plan of study may not be omitted from the degree program requirements. The course must be repeated subject to course repeat limits published in this bulletin.

The student is encouraged to monitor the Graduate Degree Works Worksheet for the appearance of fallthrough or insufficient courses that may impact the completion of degree program requirements.

Research Credit Use

Unused 591 credit (Research and Thesis for the Master's Degree) may be used to fulfill 691 credit (Research and Thesis for the Ph.D.) up to four credit hours without petition from the academic adviser. Similarly, 691 credit may be used to fulfill 591 credit up to four credit hours without petition from the academic adviser.

Right of Appeal by Petition

A student should attempt first to resolve any departure from the stated rules with his or her adviser and academic unit head whenever possible. Questions regarding theses must be referred to the thesis examiner. If necessary, the student may submit a written petition signed by the academic adviser and the academic unit head to the Associate Dean of the Graduate College explaining any extenuating circumstances and requesting a specific solution (waiver) with appropriate additional requirements that may develop. The written approval must be attached to the Form G701 Graduate Student Petition. Form G701 will not be accepted without a prior approval of the academic adviser and the academic unit head, unless the conflict is unresolved between the student and the adviser or the academic unit head. The graduate dean's decision regarding the unresolved conflict is final.

Transfer Credit

For master's degree programs, a maximum of nine credit hours taken elsewhere and not applied toward any earned degree, which were passed with grades of "B" or better, may be transferred, subject to the approval of the academic unit and the Office of Graduate Academic Affairs. Students who have completed their baccalaureate degree, master's degree, or have a master's degree in progress without an articulated dual degree admission, at Illinois Institute of Technology, with course credits in excess of the number of hours required for that degree, which were not applied toward the degree in question, may also be allowed to transfer up to nine of those excess hours. Course credits being pursued at the university in excess of the nine credit hours may be used for a degree program provided the credits were not applied toward a prior degree and the student has received the permission of the adviser, the academic unit head, and the Office of Graduate Academic Affairs **prior to** registering for any of the additional courses. Doctoral degree candidates may transfer previously completed graduate work not applied toward a prior earned degree up to a maximum of 42 credit hours beyond the baccalaureate degree (which may include up to 32 credit hours from a completed master's degree) or 50 percent of their total Ph.D. program credit hour requirements, whichever is smaller. The work must be judged to be relevant to the current doctoral program, must have been completed with grades of "B" or better, and must be acceptable for graduate credit at the institution where taken. The master's degree must have been granted within the previous six years. Grades for transferred credits will not be included in the student's GPA.

Consistent with its past practice, research credit may not be submitted for transfer credit consideration. Research credit requirements imply work that has been completed while enrolled in an Illinois Institute of Technology research course numbered 594 (master's project research), 591 (master of science research) or 691 (doctoral research).

Graduate students who have earned credit following the university's graduate transfer credit guidelines as stated earlier in this section will seek and gain initial academic approval by using the transfer credit review process in the online eForms for Graduate Degree Works system, to be reviewed by the graduate academic adviser and graduate academic department. This will require that the student submit to the adviser a copy of the course description, course syllabus, and grade report with earned credit hours (or a student copy of the transcript). The preliminary academic approval is not final without formal official transcript evaluation and approval by the Office of Graduate Academic Affairs as noted below.

U.S. Transcripts

Submission of the official certified transcript for each earned degree and/or individual course credit for consideration will be mailed or emailed directly from the institution conferring the degree to Illinois Institute of Technology.

Foreign Transcripts

Submission of the official required documents for each earned degree and/or individual course credit for consideration, as described on the World Education Services (WES) website (wes.org), is required from the institution conferring the degree (with English translation, as required, from University Language Services) to WES. WES will submit the credential evaluation results directly to Illinois Institute of Technology.

Document Submission

Illinois Institute of Technology
Office of Graduate Academic Affairs
Attention: Final Documents
10 W. 35th Street, Suite 7D7-1
Chicago, Illinois 60616
graddocs@iit.edu

Additional Information

Illinois Institute of Technology credential evaluation requirement: WES basic course-by-course evaluation (wes.org/application/sample.asp?show=crscrs)

University language translation services (transcripts not written in English) (www.universitylanguage.com/services/certified-translation/)

WES FAQs (frequently asked questions) (wes.org/application/faq)

Required documents by country (wes.org/required)

Note: Illinois Institute of Technology accepts domestic transfer credit from institutions that have obtained regional and national accreditation from agencies recognized by the U.S. Secretary of Education as reliable authorities concerning the quality of education or training offered by the institutions of higher education or higher education programs they accredit. All graduate transfer credit may only be conveyed for equivalent graduate academic courses that meet the rigor and standards of graduate education as defined by university academic standards and policies. This policy and the university's evaluation of requests for transfer credit is and is intended to be consistent with applicable federal and state laws and regulations, and any law or regulation adopted or modified after promulgation of this policy will automatically adjust this policy to the extent required for compliance with the same.

Transferring from Another Program

A degree-seeking student planning to transfer from one degree program to another should discuss the matter with academic advisers in both programs.

A student seeking to change majors within the same academic unit may submit an eForm for Graduate Degree Works request, which seeks approval by the academic adviser, academic unit head, and the Office of Graduate Academic Affairs.

A student seeking admission to a different academic unit's program is required to submit an application for admission to the desired degree program and academic unit/department online at the Graduate Admission website (admissions.iit.edu/graduate/apply). The student will be notified once the decision is made by the Office of Graduate Admission.

Certification of Official Transcripts

Completion of graduate studies and conferral of the higher degree requires degree-seeking admission to Illinois Institute of Technology (IIT), and prior completion of the prerequisite degree requirement, as outlined in the current Bulletin: Graduate Programs. Admitted graduate students are required to have earned the prerequisite degree(s) prior to enrollment in the first semester, and to present certification of the earned degree(s) during that semester. Students with an earned degree from IIT, or prior college-level work at IIT, may be exempted from the degree certification policy at the discretion of the Office of Graduate Admission.

Degree certification will be completed during the first semester of enrollment. The student is responsible for requesting all required official documents and services and for the associated costs. The university reserves the right to deny degree conferral to any student who fails to provide the required certification of official documents as outlined. In all cases, a student may not directly submit official documents to satisfy the degree certification requirement.

Master's degree students with an earned baccalaureate degree from an accredited U.S. Institution of Higher Learning: Verification of the baccalaureate degree will be satisfied by the submission of the official certified transcript for the earned degree, sent directly from the institution conferring the degree to the university's Office of Graduate Admission during the first semester of enrollment.

Master's degree students with an earned baccalaureate degree from a foreign institution of higher learning: Verification of the baccalaureate degree will be initiated by the submission of the required documents (and English translations), sent directly from the institution(s) conferring the degree(s) to the accepted international credential evaluation service (and English translation service as required). Credential certification will be satisfied when an affirmative report of the earned degree is received by the university from the accepted international credential evaluation service. Visit the Office of Graduate Admission website (admissions.iit.edu/graduate) for details on submitting the official documents to an accepted international credential evaluation service.

Doctoral students with master's-level and/or baccalaureate degree(s) from an accredited U.S. Institution of Higher Learning: Verification of all earned degrees will be satisfied by the submission of the official certified transcript, for each earned degree, sent directly from the institution conferring the degree(s) to the Office of Graduate Admission (admissions.iit.edu/graduate) during the first semester of enrollment at the university.

Doctoral students with master's-level and/or baccalaureate degrees from a foreign institution of higher learning: Verification of all earned degrees will be initiated by the submission of the official required documents (and English translations), sent directly from the institution(s) conferring the degree(s) to the accepted international credential evaluation service (and English translation service as required). Credential certification will be satisfied when an affirmative report of the earned degree(s) is received by the university from the accepted international credential evaluation service. Visit the Office of Graduate Admission website: admissions.iit.edu/graduate for details on submitting the official documents to an accepted international credential evaluation service.

Failure to provide the required certification of the earned degree(s) will prevent degree conferral. Should the review of official documents fail authentication, the student will be dismissed from graduate study at the university.

For any questions regarding the submission and/or certification of official transcripts, please contact the Office of Graduate Admission (admissions.iit.edu/graduate).

Examinations

Master's Examinations

Master's Comprehensive Examination

The master's comprehensive examination is used to determine whether the student has acquired the knowledge commensurate with the courses shown in the student's plan of study. The examination may be oral, or written, or both. The academic unit determines the form, scope, and time of the examination. The master's thesis examination may serve as the comprehensive examination. The academic unit has the option of offering professional master's degrees with a minimum of 30 credit hours without requiring a comprehensive exam (i.e. coursework only). In the case of an oral examination, at least two Category I (tenure-track) faculty members must be present to serve in the student's committee at the examination. One external, non-Illinois Institute of Technology faculty or other faculty categories at the university, committee member with voting privilege may be included with the approval of the Associate Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the Associate Dean of the Graduate College. A resume should be attached to the recommendation. Other faculty and external visitors may attend. The result of the examination must be approved by a majority of the committee. The committee's decision must be submitted to the Office of Graduate Academic Affairs on Form G303 at least 15 days prior to the end of the semester. The graduate student must be registered in the semester in which the examination is given. A student who fails the comprehensive examination may repeat the examination once after a period of at least 30 days from the initial examination. Any additional consideration must be petitioned, supported by the academic unit, and approved in writing by the Associate Dean of the Graduate College.

Master's Thesis Examination

Once the preliminary draft of a master's thesis is prepared, the head of the student's academic unit will appoint a master's thesis committee consisting of at least two or more Category I (tenure-track) faculty members. One external, non-Illinois Institute of Technology or other faculty categories at the university, committee member with voting privilege may be included with the approval of the Associate Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the Associate Dean of the Graduate College. A resume should be attached to the recommendation. The thesis committee is responsible for approving the preliminary thesis draft using Form G501A, which the student brings to the thesis examiner prior to the final oral examination. The form, scope, and time of the examination are determined by the academic unit. The examination result must be submitted on Form G303 at least 15 days prior to the last day of courses. The graduate student must be registered in the semester in which the examination is taken. A student who fails the thesis examination may repeat the examination once after a period of at least 30 days from the initial examination. Any additional consideration must be petitioned, supported by the academic unit, and approved in writing by the Associate Dean of the Graduate College.

Doctoral Examinations

Qualifying Examination

A qualifying examination is required for all doctoral students. The composition of the qualifying examination committee is determined by the academic unit. The voting members of the committee should be Category I faculty. One external, non-Illinois Institute of Technology or other faculty categories at the university, committee member with voting privilege may be included with the approval of the Associate Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the Associate Dean of the Graduate College. A resume should be attached to the recommendation. The exam may be given along with the master's comprehensive examination. Students must be registered in the semester in which the qualifying examination is administered. The following rules apply to the qualifying examination:

1. The qualifying examination may be written and/or oral, and cover major and minor subjects.

2. If the academic unit requires a written exam, the student's committee is responsible for submitting the questions and for conducting the exam. The committee may conduct an oral portion of the qualifying examination. A minimum of four Category I (tenure-track) faculty members must participate in the oral portion of the examination.

3. The examination must be taken within the first year of Ph.D. study if the student has an M.S. degree.

4. All work for a doctoral degree must be completed within six calendar years after the approval of the program.

5. The results of the qualifying examination must be submitted within fifteen days of the administration of the examination on Form G303 to the Office of Graduate Academic Affairs.

6. If the student fails the qualifying examination, the examining committee may recommend a re-examination. At least one semester of additional preparation is considered essential before re-examination. The second chance for taking the qualifying exam is regarded as final.

Any additional considerations must be petitioned, supported in writing by the academic unit, and approved in writing by the Associate Dean of the Graduate College.

Comprehensive Examination

After the approval of a plan of study and within a period of time specified by the academic unit, the student must appear for the comprehensive examination. Though students typically take this examination at the end of the second year of Ph.D. study, the only time requirement is that the comprehensive examination is completed at least one year prior to the final thesis examination. The student must be registered in the semester in which the examination is taken. The proposal for the Ph.D. dissertation is normally presented as part of the comprehensive examination. The following rules apply to the comprehensive examination:

1. The examination may be written, oral, or both.

2. A minimum of four Category I (tenure-track) faculty are required for all examining committees of doctoral candidates. The chair and two other members from the committee must be from the student's major, and the fourth member must be from outside the student's major (e.g., MAE faculty may serve on an MSE student committee). One external, non-Illinois Institute of Technology or other faculty categories at the university, committee member with voting privilege may be included with the approval of the Associate Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the Associate Dean of the Graduate College. A resume should be attached to the recommendation. The graduate dean is an ex-officio member of all examining committees. To substitute for the chair of the committee, the new chair must be a Category I (tenure-track) faculty member in the same academic unit. The role of the outside member of the committee is to provide an element in the examining committee function that is independent of the immediate interest of the academic unit in which the candidate is seeking his or her degree. The outside member of the committee has the responsibility of representing the interest and function of the Graduate College and the university in a context distinct from that of the degree-granting academic unit. Faculty holding joint or adjunct appointments in the degree-granting academic unit or non-faculty co-advisers cannot be outside members on a student's committee. They may, however, serve as the additional members of the committee.

3. The committee is nominated by the academic unit head and confirmed by the Office of Graduate Academic Affairs. The nominations must be arranged on Form G301A by the end of the third week of the semester in which the examination is going to be held. The Office of Graduate Academic Affairs must be notified on Form G301A of the time and date of the comprehensive examination no later than two weeks prior to the exam date.

4. Any faculty member may attend oral comprehensive examinations, but only the appointed Category I and external committee members may vote. Passing the examination requires one vote more than a majority of the official committee. Dissenting members may bring a split decision before the graduate dean for adjudication.

5. If part of the examination is failed, the report should note which part is to be repeated in a second examination. A student who fails the comprehensive examination may be re-examined after a period of 30 days has elapsed. Students failing the examination twice will be asked to terminate their graduate study at the university. In extenuating circumstances the academic unit head may show cause why a third examination should be given. A re-examination after two failures requires the approval of the Associate Dean of the Graduate College. Failure of the third examination will result in termination without recourse.

Final Thesis Examination

The final thesis examination may be scheduled at least one year after the comprehensive examination. The following rules apply to the final thesis examination:

1. The eligibility for the membership of the final thesis examination is the same as that listed earlier for the comprehensive examination. The examining committee must consist of at least four Category I (tenure-track) faculty members who must sign Form G301B. One external, non-Illinois Institute of Technology or other faculty categories at the university, committee member with voting privilege may be included with the approval of the Associate Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the Associate Dean of the Graduate College. A resume should be attached to the recommendation. Faculty members holding the rank of research professor or associate professor may be appointed as non-voting co-chairs of the final thesis examination committee. An emeritus professor who has a current research professor appointment and who has been active in guiding and supporting the student may be a co-chair and voting member of the student's committee. The examining committee is nominated by the academic unit head and confirmed by the Office of Graduate Academic Affairs by the second week of the semester in which the examination will be administered.

2. At least five weeks prior to the last day of the semester, the preliminary draft of the thesis must be approved on Form G501A by the committee and by the thesis examiner before the student's appearance for the oral examination. The oral examination will be canceled if the preliminary draft is not acceptable before the scheduled time for the oral examination.

3. Form G501A is to be signed by committee members as they receive the draft of the final copy of the dissertation prior to the defense and for review. The approval of Form G501A indicates that faculty members have received a copy of the dissertation and are willing to read and comment on it. The members of the committee are not allowed to share the content of the draft with any outside individuals without the permission of the committee chair. After the first submission of the dissertation, the thesis examiner checks Form G501A for signatures

of committee members and the academic unit head. The thesis examiner also checks the format, paper stock and pagination, and reviews portions of the text for general usage, references, and bibliographic form.

4. Upon final submission, the signature pages and the final thesis approval form (Form G501B) are checked by the thesis examiner for signatures of committee members and the academic unit head. The signatures on Form G501B indicate that the committee members are satisfied with the content of the dissertation and no additional changes are required before its final online submission for the thesis examiner's review. It is the responsibility of the student and the committee chair to notify the Office of Graduate Academic Affairs of any changes in the structure of the examining committee. The same committee that approved the preliminary dissertation must also approve the final copy of the dissertation.

5. The examination is open to all faculty but only the appointed committee members may vote. The chair of the committee is responsible for the conduct of the examination. In addition, Form G301B must be received by the Office of Graduate Academic Affairs by the end of the second week of the semester in which the examination is going to be held. The Office of Graduate Academic Affairs must be notified of the date and time of the final thesis examination at least two weeks before the examination using Form G301B. Examination results reported on Form 309 must be received in the Office of Graduate Academic Affairs at least 15 days before the last day of the semester. The final copy of the thesis is uploaded by the student using an online document submission process, confirmed by the thesis examiner with the degree candidate, at least nine days before the last day of the semester.

6. A student who fails the thesis examination may be re-examined after a period of 30 days has elapsed. Students failing the examination twice will be asked to terminate their graduate study at the university. In extenuating circumstances the academic unit head may show cause why a third examination should be given. A re-examination after two failures requires the approval of the Associate Dean of the Graduate College. Failure of the third examination will result in termination without recourse.

Qualifying, comprehensive, and final examinations for graduate students are to be held on the university's Mies Campus. Exceptions to this policy are made only for certain graduate students whose examinations are administered at other university campuses.

Grades and Transcripts

Grades

The following grades are given to graduate students and count in calculating a student's cumulative GPA as noted by quality hours. GPA is calculated by dividing the total number of grade points earned by the total number of graded semester or quarter hours. Courses not taken at Illinois Institute of Technology are not included in computing the GPA. Students may access their grades online in the MyIIT portal (my.iit.edu), under the Academics tab.

Grade	Grade Description	Instructor Assigned	Performance Evaluation	Attempted Hours	Earned Hours	Quality Points	Quality Hours	GPA Hours	FinAid Hours
A	excellent	x	x	x	x	4.00	x	x	x
B	above average	x	x	x	x	3.00	x	x	x
C	average	x	x	x	x	2.00	x	x	x
E	fail	x	x	x		0.00	x	x	x
I	incomplete	x		x		0.00			x
R	research	x		x		0.00			x
NA	non-attendance	x		x		0.00			x
S	satisfactory	x	x	x	x	0.00			x
U	unsatisfactory	x	x	x		0.00			x
P	pass	x	x	x	x	0.00			
F	fail	x	x	x		0.00			
AU	audit					0.00			
W	withdrawal (student initiated)			x		0.00			x
X	no grade submitted			x		0.00			x
NG	non-graded					0.00			

Incomplete ("I") Grade

The "I" grade is a temporary grade requested by the student, of the instructor, through the incomplete grade request process, prior to the week of finals. An "I" grade is automatically posted when the Office of the Registrar receives the approved request. A written agreement between the student and instructor must detail the remaining requirements for successful completion of the course. A grade of "I" will be assigned only in case of illness or unforeseeable circumstances that prevent the student from completing the course requirements by the end of the term. Grades of "I" will automatically lapse to "E" on the published deadline of the subsequent term.

"R" Grade

In the case of research courses, courses numbered 591 and 691, the grade of "R" may be assigned for the reasons listed above and will remain until the student has satisfactorily completed the course work. Once assigned, the grade of "R" will remain on the student's transcript until the research as determined by the research professor is completed. "R" grades should be removed as soon as possible and no later than the start of the semester in which the student plans to graduate.

Non-Attendance "NA" Grade

A grade of "NA" indicates an apparent withdrawal as a result of the student never attending a registered section. Students who never attended class and remained registered should receive a midterm grade of "NA" to indicate an apparent withdrawal due to non-attendance. The "NA" grade is not available as a final grade.

Withdraw ("W") Grade

The withdraw grade is issued to students who withdraw from a class after the term has begun. The "W" cannot be changed to a standard letter grade.

Satisfactory ("S") and Unsatisfactory ("U") Grades

Satisfactory ("S") and unsatisfactory ("U") grades are only used for the following courses: 591 (Research and Thesis), 594 (Project and Report), 691 (Research and Thesis), noncredit courses, and individual courses specifically approved to receive such grades. A student who receives a "U" in course numbers 591, 594, or 691 must demonstrate to his or her adviser, academic unit head, and the Graduate College, Office of Academic Affairs why he or she should be allowed to continue as a graduate student. Students registered for course number 597 are not eligible for "S/U" grades. "S/U" grades are not used in calculating the GPA.

Audit ("AU")

In general, grades of "E", "I", "R", "U", "W", "NA", or "AU" cannot be used to fulfill the requirements of a graduate program. Auditing of courses is discouraged, but a student may do so if he or she has taken the necessary prerequisites, if the student's presence does not exclude a student who wishes to enroll for credit and if the student's presence does not distract from the conduct of the course as determined by the instructor. An auditor must pay full tuition for the course but is not held for examinations and does not receive credit. Auditors may not change their registration to receive credit after the deadline posted in the Enrollment Guide. The "AU" grade issued for an audited course can never be changed, used for graduate credit, or for fulfillment of degree requirements at the university.

Change of Grade

The change of grade request form is available on the Office of the Registrar's portal site. This form is intended for the exclusive use of Illinois Institute of Technology faculty and authorized academic administrators to request a student's official final grade be changed. Online submissions of final grades are due on the published deadline following final exams. Grades of "X" are posted for all missing (blank) grades at that time and are resolved through this grade change process. All grade changes are initiated by the instructor of record or authorized academic officer. Using this form, temporary grades of "I", "R", and "X" can be changed by the instructor directly with the Office of the Registrar to a final letter grade of: "A", "B", "C", "E", or "S/U" if the class has a pass/fail grading basis of satisfactory/unsatisfactory. Temporary grades of "I" or "R" cannot be changed by the instructor to another temporary or non-letter, administrative grade of "I", "R", "NA", "AU", "W", or "X. Other grade changes may require an additional level of approval by an academic officer or appeals committee. The student should check with his or her academic college dean's office for details. Changes to final grades cannot be made once a degree has been posted for the career in which the course was taken, or in the case of a student's involuntary separation from the university. Grade change submissions through this form are recorded in Banner once the submitting instructor and/or administrative academic authorization is verified. The instructor is notified when the process is complete.

Repeating a Course

Students may repeat up to two distinct courses with each course being repeated once. Both grades will be recorded and the grade used in the calculation of the GPA will be the latest recorded. Re-registration to repeat a course will require the permission of the student's adviser, academic unit head, and the associate dean for academic affairs, and will also require completion of the "Course Repeat Form", or the G702 Probation Contract, when applicable. This form must be submitted at the time of registration and can be accessed online at the Office of the Registrar's website (web.iit.edu/registrar/registration). The original course grade earned will remain on the student's academic transcript.

Transcripts

Official transcripts are requested through the Office of the Registrar and are only released with the expressed consent and authorization of the student, in compliance with the Family Educational Rights and Privacy Act of 1974 (FERPA). The secured document is certified as of the printing date and is not valid if altered in any way or opened by someone other than the intended recipient.

Official transcripts are released only after the student has fulfilled all financial obligations to the university. Official transcripts issued directly to the student making the request are stamped “ISSUED TO STUDENT”. A fee is charged for each transcript issued.

Graduation

As part of the requirements for the completion of graduate studies at the university, each student must be admitted as a regular (degree-seeking) student and file and complete a plan of study approved by the corresponding degree program officials and the Office of Graduate Academic Affairs. Ph.D. students must also pass the qualifying, comprehensive, and oral defense examinations, fulfill the residence requirement, and submit a dissertation before graduation. (Students should refer to the Synopsis of Graduate Studies portion (p. 31) of this bulletin for a list of steps and corresponding forms that must be completed, the detailed degree requirements listed under the relevant academic unit in this bulletin, and the information regarding program changes, for additional information).

Completion of Degree

Master’s Degree Candidates

The starting date for any course applied toward the degree must be no earlier than six years before the graduation date. If this condition cannot be met, the student may petition the Associate Dean of the Graduate College for an extension. Any courses that fall outside the six-year time limit must be revalidated. Form G504 Revalidation of Outdated Courses is used to initiate the petition and the subsequent revalidation process (p. 483) as published in the Graduate Bulletin. The M.S. Comprehensive (Thesis) Examination will serve the purpose of revalidating the outdated plan of study

Doctoral Candidates

Doctoral study must be completed within six years of the date of approval of the plan of study. An extension will require an agreed upon schedule for the completion of remaining degree requirements. Any courses that fall outside the six-year limit must be revalidated. Form G504 Revalidation of Outdated Courses is used to initiate the petition and the subsequent revalidation process (p. 483) as published in the Graduate Bulletin. The Ph.D. Comprehensive Examination will serve the purpose of revalidating the outdated plan of study.

Application for Graduation

Students expecting to graduate in a given semester must file an Application for Graduation online using Banner Student Self Service located in the MyIIT portal (my.iit.edu), which is is submitted to the Office of Graduate Academic Affairs, by the deadline listed in the Academic Calendar for the semester of graduation. See the Plan of Study and Degree Program Requirements section (p. 475) published in the Graduate Bulletin. Students’ names may be deleted from the graduation list upon request, but no new names will be added after the deadline. Upon submission of a graduation application, the Office of Graduate Academic Affairs will check for completion of the student’s degree requirements. The diploma will be issued by the Office of the Registrar after grades are reported, usually about four to six weeks after the end of the term. Students who participate in the annual graduation commencement ceremony in spring semester will receive the diploma for their earned degree at the ceremony. Students should not file the Application for Graduation form unless they are reasonably sure that they can complete the degree requirements in time to meet the deadlines. An application for graduation is valid for one semester; however, if the student fails to graduate in the intended semester, the application will be reconsidered in the following semester. Failure to fulfill degree requirements within the first semester of application for graduation will result in the need to enroll in a continuation of graduate study course (GCS 600 or 100). The permit for this course is requested using Form G701 Graduate Student Petition.

A late graduation fee will be charged to any graduate student who seeks special consideration for failing to apply for graduation by the semester deadline, as published in the Academic Calendar (p. 7). The student is required to include an explanation of the extenuating circumstance that requires this consideration. A late application for graduation may only be considered when filed no later than 30 days prior to the last day of the semester, as published in the Academic Calendar. Paper Form G527L Late Application for Graduation will be submitted by the student to the Office of Graduate Academic Affairs to initiate this special consideration. A late graduation application fee will be charged to the student’s account, in addition to the current applicable graduation application fee.

Professional Master’s Degree

A professional master’s degree is offered to graduate students who seek the non-thesis option. As used here, a thesis is a written document or manuscript that concerns an investigation or discourse. A professional master’s degree program may require a project and a project report (e.g., course 594); however, neither the project itself nor the project report is considered a thesis. Storage of project reports will be at the discretion of academic units and cannot be done in the university library. Registration for thesis research cannot fulfill a requirement for a non–thesis degree, unless a petition approved by the academic unit and the Associate Dean of the Graduate College, subject to the limits of a project course (594) and the acceptable report of final project work, is filed and approved by the academic adviser, academic unit head, and the Office of Graduate Academic Affairs.

Certificate Conferral

A graduate certificate program (GCP) is defined as a group of three to five 400- and 500-level courses in a concentration within a department or program organized with the objective of training students in a specific area of expertise. Admission to a GCP is limited to students who qualify as non-degree graduate students who hold a bachelor's degree with a GPA of 2.5/4.0 or higher. The GRE is not required. Admission as a certificate student does not guarantee future admission to a graduate degree program.

Course requirements for a GCP are determined by the individual department, and must have a minimum of nine credit hours with at least one course at the 500-level. No more than nine credit hours of 400-level courses can be included; no more than half the credits or courses may be specialized (topical) accelerated courses. Transfer credit cannot be applied toward a graduate certificate.

The time limit for its completion is three years. A student may complete more than one graduate certificate if admitted to each.

A GPA of 3.0/4.0 or greater is required in the certificate courses before a graduate certificate can be awarded. Form G528 Application for a Graduate Certificate must be filed by certificate students delineating the courses completed for a particular graduate certificate. This form is available from the Office of Graduate Academic Affairs, and must be approved by that office and by the academic unit head.

The completion of a GCP will be indicated on the student's transcript. A certificate student who subsequently applies to and is admitted to a specific master's degree program may apply all approved coursework taken as a certificate student and passed with a "B" grade or better to the master's degree program.

Letter of Completion

A student who has completed all the requirements for graduation may request a letter of completion from the Office of Graduate Academic Affairs at any time during the semester. The student will not receive his or her diploma until grades are reported by the Office of the Registrar, usually within four to six weeks after the end of the semester or term. Form G704 Request for Letter of Completion is used to initiate the request.

Time Limit to Complete a Degree

All requirements for a master's degree must be completed within the twelve semesters immediately preceding graduation. All requirements for a doctoral degree must be completed within twelve regular semesters after the approval of the Plan of Study. If the twelve-semester deadline is not met, then a Form G701 Graduate Student Petition for extension must be filed by the student and the outdated courses listed on the student's Plan of Study in Graduate Degree Works must be revalidated. The petition must include a detailed plan for the completion of the degree and be endorsed by the academic adviser and the academic unit head. The student's petition for extension must be presented before the time limit is reached. The Associate Dean of the Graduate College will notify the student of the decision and any additional requirements that must be met. In no case will an approved extension of time eliminate the need for revalidation of outdated courses for a graduate degree at the university. A statement from the academic unit head indicating the list of courses on the student's Plan of Study that are to be revalidated (Form G504) and the expected date for the revalidation must accompany the extension approval. The M.S. or Ph.D. comprehensive or thesis examination may serve the purpose of revalidating the outdated Plan of Study.

Leaves and Withdrawals

Leave of Absence

Degree-seeking students who intend to leave the university for one semester or more must complete the online leave of absence form in the MyIIT portal (my.iit.edu) by selecting the Academics tab, followed by the Graduate Academic Affairs channel. A leave of absence will not be granted for more than one year, at which time, a request for an extension of leave may be submitted by filing a Form 701 Graduate Student Petition. A leave of absence will not extend the time limit required for the completion of a degree. A leave will not be approved after the sixth week of the current semester. A student who has not renewed his or her leave of absence must petition for reinstatement to the Office of Graduate Academic Affairs. Degree-seeking students who do not plan to return to the program should submit a Withdrawal From the University Request, also located as noted above. Non-degree students are not required to file a Leave of Absence Form, but will require reinstatement by petition on Form G701 after a lapse in registration. Students should consult the procedures for filing a petition under the section Right of Appeal by Petition (p. 476) in the Graduate Bulletin.

Note: International students must also receive a separate approval from the International Center. If an international student wishes not to enroll in a given term, the leave of absence must be approved by the International Center by the registration deadline of that term.

Reinstatement

Degree-seeking graduate students who discontinue their studies without an official request for leave of absence may later be refused reinstatement or enrollment at the university. Students with an unofficial interruption of studies must petition for reinstatement to the Office of Graduate Academic Affairs using the Form G701 Graduate Student Petition. Students should contact the Office of Graduate Academic Affairs for additional information. Procedures for filing a petition may be found within the Right of Appeal by Petition section (p. 476) of the Graduate Bulletin.

Withdrawal from the University

A student who wishes to withdraw should first consult his academic adviser. The adviser may be able to suggest resources or alternate solutions to the student's problems. An international student wishing to withdraw is required to consult the international student adviser in the International Center as well. For withdrawal, all graduate students must complete the electronic withdrawal form online in the MyIIT portal (my.iit.edu) by selecting the option from the Graduate Academic Affairs channel. Withdrawal from the university is not complete until an official email is received by the student confirming its completion. International students will receive two separate emails: 1) confirming the international status and 2) the academic program withdrawal outcome.

Registration

Full-Time Versus Part-Time Status

Full-time students are regular, matriculated students that meet any of the following criteria:

1. Register for a minimum of nine credit hours per semester (six credit hours in summer).
2. Hold university-approved fellowships, or teaching or research assistantships, regardless of the number of credits of registration. Additional restrictions may apply to International students enrolled for less than six credit hours. Consult the International Center.
3. Are occupied with an academic activity that mandates an equivalent of full-time study, regardless of the number of credits of registration. (This privilege may be used in a limited number of occasions and requires the written consent of the faculty adviser and the endorsement of the Associate Dean of the Graduate College.)

Note: Full-time international students must fall into categories (1) or (2). International students enrolling less than full-time in the semester of graduation or falling into category (3) must file a petition (less than full-time eligibility) in the International Center by the registration deadline. In order for the nine credit hours of registration to be considered full-time, only one course may be audited. International students may only take one online course per term to count towards their full-time enrollment. The maximum study load for regular students is 15 credit hours per semester except by permission of the Office of Graduate Academic Affairs. During the summer session, the normal study load is six credit hours.

Part-time students are those who do not fulfill any of the above criteria for full-time students.

Minimum Registration Requirements

Any graduate student who is using university facilities and/or faculty time must register for a minimum of one credit hour in fall, spring, and summer semesters. A student must be registered:

1. During the semester of qualifying and comprehensive examinations
2. During the semester of final thesis defense
3. During the semester in which the degree is awarded

A graduate student who receives any type of stipend must meet the minimum registration requirements for the fall and spring semesters. Occasionally, students may need to complete an internship or thesis or dissertation fieldwork away from the university as part of their academic program; those students may petition to be considered full-time while conducting field research or completing an internship if they previously satisfied the university residency requirements. The full-time equivalent for such students is one credit hour. The Form G701 Graduate Student Petition must be endorsed by the student’s adviser and academic unit head, and forwarded to the Associate Dean of the Graduate College for approval.

An international student on F-1 or J-1 visa must register for nine credit hours throughout his/her studies at Illinois Institute of Technology, except in the last semester. In certain circumstances, including the last semester of enrollment, less-than-full-time is allowed with approval of the academic unit and International Center. If the student has an appointment as a TA or RA, he/she is allowed to reduce their registration to six credit hours. A less-than-full-time permission form has to be filed with the International Center in such cases.

Course Numbering

Course numbers 100–399 are primarily used for undergraduate courses. Courses 400–499 may be used for minor credit or as prerequisites when taken as part of an approved graduate program (see department requirements: a maximum of 12 credit hours of 400-level classes may be included). Courses numbered 500–799 are graduate level and are primarily for graduate students; the grade earned by graduate students must be a “C” or better.

Course Descriptions

Course descriptions are available in the departmental sections of this bulletin and online in the MyIIT portal (my.iit.edu) under the Academics tab.

Registration for Fall and Spring Semesters

Specific procedures and regulations for registration are found each semester in the MyIIT portal under the Academics tab. Please visit the academic calendar (p. 7) for publication dates for class schedules. Students who were admitted to, but did not attend, the university must be readmitted by the Office of Graduate Admission before they can register. Continuing students may register for classes through regular registration procedures online in the MyIIT portal. All graduate students registering for courses numbered 591, 594, 597, and 691 must receive written or online approval from their faculty adviser before registration. These registrations may be completed through web registration if an online permit is submitted by the course adviser/instructor.

For more information, visit the Office of the Registrar website at web.iit.edu/registrar.

Registration for T.A. Seminar

All new teaching assistants are required to register for a zero-credit hour T.A. seminar (department's course number 601) given every fall semester.

Registration for Continuation of Residence

Degree-seeking students in the final semester are allowed to register for one semester of non-credit, or a continuation of residence (course number 600), for a fee equivalent to one credit hour. The academic unit provides the permit for this course.

Students who have successfully completed the master's thesis defense or doctoral oral defense may petition to register for GCS 600 for one credit hour, at a nominal charge. The permit for enrollment in this course is approved by the Office of Graduate Academic Affairs after confirmation of the defense result. Form G701 is used to request the GCS 600 permit.

IPRO Registration

Graduate students may serve as project leaders on an Interprofessional Project (IPRO). A student who wishes to do so must first consult his or her academic adviser and the project adviser. With the approval of both, the student should register for IPRO 597.

Change of Registration After Initial Registration

The term "change of registration" means adding a course (a "course" includes courses, projects or research courses/hours); dropping a course; shifting from one section to another in the same course; or changing the number of credit hours in a variable-credit course (e.g., research hours). A course may not be added or changed to another section after the second week of course instruction during the spring and fall semesters. Visit the academic calendar (p. 7) for details.

The change of registration may be completed in the MyIIT portal in Banner Self Service. Students requiring assistance may contact the Office of the Registrar (registrar@iit.edu). A course may be dropped during the first two weeks of the regular semester for refund or credit, and during the first week of the summer semester. A course may be withdrawn with no refund or credit between the third and the tenth week of the semester. No courses may be withdrawn after the withdrawal deadline; extenuating circumstances must be petitioned for review in the Office of Graduate Academic Affairs. No registration change or withdrawal is official until the form is approved by the Office of the Registrar. Notifying the instructor or merely discontinuing course attendance is not sufficient for withdrawal. The date of the withdrawal form will be the official date of withdrawal. All billing inquiries related to registration changes may be referred to the One Stop (onestop@iit.edu, 312.567.3810). International students are required to remain full-time (i.e. carry nine credit hours of study) and may not change their registration to become part-time except in the semester of graduation. (Students should refer to the note under Minimum Registration Requirements (p. 484).)

Undergraduates Registering for Graduate Courses

An undergraduate degree-seeking student who wishes to enroll in a graduate 500-level course must first obtain written approval from the course instructor and faculty adviser stating that the student is qualified. An undergraduate student registering for more than nine credit hours of graduate courses must also obtain written approval from the Associate Dean of the Graduate College. This approval must be presented prior to registration. An undergraduate non-degree student may be permitted to enroll in a graduate 500-level course in certain instances, but will require the permission of the Office of Undergraduate Academic Affairs and the Associate Dean of the Graduate College. All undergraduate students who enroll in graduate courses are governed by the graduate grading system for those courses. Failure to obtain the appropriate approvals may prevent transfer of credits earned into graduate degree programs at the university. No credits approved toward the undergraduate degree requirements will transfer into any graduate program at the university without the required and relevant co-terminal program admission. Students should consult the rules for transfer of credit under the Transfer Credit section (p. 476) of the Graduate Bulletin.

Note: Students admitted to co-terminal undergraduate and graduate studies should review the Synopsis of Co-Terminal Studies (p. 33) in the Graduate Bulletin.

Accelerated Graduate Courses

An accelerated course is a graduate-level course offered in a two-week (14-day) or shorter duration of time, and satisfies the lecture contact-time standard of fifteen 50-minute class sessions per semester credit hour, excluding final exam time. These are topical courses that should be no more than three credit hours. A new accelerated course is subject to the normal departmental review as for a regular new graduate course. Approval is required by the department curriculum committee, the academic unit head and the Associate Dean of the Graduate College. No more than six credit hours of accelerated courses may be included in a master's degree program of study. Accelerated courses can be selectively included in a Ph.D. program of study at the rate of six credit hours per 32 course credit hours, and their inclusion is subject to approval of the adviser, academic unit head, and the Office of Graduate Academic Affairs.

Students must register for the accelerated course before the first class session in order to receive credit for the course.

Class Attendance

All students are expected to attend their courses regularly. Excessive absences may cause a student to be withdrawn from the course at the discretion of the instructor, academic unit head, and the Associate Dean of the Graduate College. A withdrawn student receives a grade of "W" in the particular course. In the case of illness or other emergencies that require a student to be absent for more than two days of courses, the Dean of Student Affairs should be notified at the earliest possible date. In case of an emergency on campus, students should contact the Public Safety Department at 312.808.6300.

Religious Accommodations

Section 1.5 of The University Religious Observances Act (110 ILCS 110/1.5) provides: "Any student in an institution of higher learning, other than a religious or denominational institution of higher learning, who is unable, because of his or her religious beliefs, to attend classes or to participate in any examination, study, or work requirement on a particular day shall be excused from any such examination, study, or work requirement and shall be provided with an opportunity to make up the examination, study, or work requirement that he or she may have missed because of such absence on a particular day; provided that the student notifies the faculty member or instructor well in advance of any anticipated absence or a pending conflict between a scheduled class and the religious observance and provided that the make-up examination, study, or work does not create an unreasonable burden upon the institution. No fees of any kind shall be charged by the institution for making available to the student such an opportunity. No adverse or prejudicial effects shall result to any student because of his or her availing himself or herself of the provisions of this Section." Illinois Institute of Technology complies with the requirements of the foregoing statute.

Interstate Registration Disclaimer

IIT-Chicago-Kent College of Law is registered with the Minnesota Office of Higher Education pursuant to Minnesota Statutes sections 136A.61 to 136A.71. Registration is not an endorsement of the institution. Credits earned at the institution may not transfer to all other institutions.

Residence Requirement

Degree-seeking graduate students are required to register every fall and spring semester unless they receive special permission in writing from the Office of Graduate Academic Affairs for a leave of absence. In addition, doctoral students must spend a minimum of one year of full-time study at the university. (Students should consult the definitions of a full-time student and credit requirements listed within the Graduate Bulletin). That year must occur within six years prior to awarding the degree. Some academic units have academic residence requirements for master's degrees as well.

Thesis

Thesis Preparation Meeting

A mandatory thesis preparation discussion is held at the beginning of every semester to assist graduate students with the preparation of their theses. The exact date and time is emailed to all graduation applicants by the Office of Graduate Academic Affairs. All students who are required to submit a thesis for graduation must attend this meeting, which is open to all students, faculty, and staff. Graduate student theses must conform to the guidelines given in the latest Illinois Institute of Technology Thesis Manual, available online at web.iit.edu/gaa/thesis.

Thesis Examination Appointments

All students submitting a thesis must make an appointment with the thesis examiner for the approval of the preliminary draft of their theses. The meeting with the thesis examiner must be scheduled at least six weeks before the end of the semester and prior to the thesis defense. At least five weeks before the end of the semester of graduation, all students submitting a thesis must make a second appointment with the thesis examiner for the approval of the final draft.

The second meeting with the thesis examiner must take place after the thesis defense and the approval of the final draft by the thesis review committee.

Students are expected to adhere to all thesis and dissertation deadlines as published in the semester Sequence of Events, available online at web.iit.edu/gaa/students/dates-and-deadlines.

Appointments may be made by calling 312.567.3024.

GENERAL POLICIES

Regulations Subject to Change

Regulations and policy guidelines are established by the Graduate Studies Committee, composed of the Vice Provost for Academic Affairs, the Associate Dean of the Graduate College, and an elected representative from each graduate degree program on the Mies Campus.

Every attempt is made to keep this bulletin up to date; students, however, should consult the Office of Graduate Academic Affairs or the academic unit head for revisions and updates. The current version of the Graduate Bulletin is maintained on the Academic Affairs website at web.iit.edu/academic-affairs.

Change of Records Information

Students must promptly advise the Office of the Registrar and their respective academic units if they change their name, Social Security Number, mailing address, or telephone number. Students can find instructions on how to update their personal information, including name, identification number, mailing address, and next-of-kin address, online at web.iit.edu/registrar/academics/update-personal-information.

Standards of Conduct

Students are responsible for their own conduct; university regulations and requirements are published in the Student Handbook. Graduate students are also subject to the rules and regulations published in this bulletin. Illinois Institute of Technology reserves the right to terminate a student's enrollment or to deny enrollment when it is judged to be in the best interest of the student or the university. The Student Handbook is available online at web.iit.edu/student-affairs/handbook.

Campus Resources

Academic Resource Center

Hermann Hall, Room 112
312.567.5216
iit.edu/arc

The Academic Resource Center (ARC) is a comprehensive center with a variety of services for students and faculty. The ARC's mission is to enrich the academic experience through a student-centered approach to learning. The ARC provides peer tutoring in mathematics, architecture, engineering, and the sciences on a drop-in basis and by appointment.

Undergraduate and graduate peer tutors are available during the fall, spring, and summer semesters. In addition to peer tutoring, the ARC also offers exam reviews, workshops, supplemental instruction, group study space, and an OTS computer laboratory including PCs and Macs. The ARC also keeps some textbooks and iPads with academic apps for reference.

The peer tutors will assist with academic software, such as: Java, Excel, SPSS, MATLAB, Mathematica, AutoCAD and more. The ARC's focus is towards undergraduate courses at Illinois Institute of Technology. Graduate students can use the ARC's user-friendly space, printers, scanner, and computers.

The ARC is open Monday through Thursday, 10 a.m.–8 p.m.; Friday, 10 a.m.–3 p.m.; and Sunday from 6 p.m.–9 p.m. For more details, visit the ARC website or call 312.567.5216.

Access, Card, and Parking Services

Hermann Hall, Room 201
iit.edu/acaps

The Access, Card, and Parking Services Office issues HawkCards and parking permits for the university. The HawkCard is the photo identification card for Illinois Institute of Technology students, staff, and faculty. Not only does it serve as a form of ID, it also grants access to buildings, parking lots, computer labs, Keating Athletic Center, the shuttle bus, library materials' check-out services, and TechCash balances. Permits to park in university lots are available for purchase on a semester, monthly, or weekly basis. Students should visit Access, Card, and Parking Services in Hermann Hall, Room 201 or log in to their MyParking account.

Athletics and Recreation

illinoistechathletics.com

Intercollegiate Athletics

Illinois Institute of Technology is currently transitioning to NCAA Division III status and is entering the third year of the provisional process. The university offers the following intercollegiate sports: men's and women's soccer, men's and women's cross country, men's and women's basketball, men's and women's volleyball, men's and women's swimming and diving, men's and women's indoor track and field, men's and women's outdoor track and field, women's lacrosse and baseball. Men's and women's tennis will be installed as varsity programs in the 2017-2018 academic year.

As the athletic department switches to NCAA Division III competition, Scarlet Hawk student-athletes will have the opportunity to face strong competition from other DIII Midwest members.

The university also holds full membership in the United State Collegiate Athletic Association (USCAA). The USCAA focuses specifically on smaller institutions of higher learning and provides Scarlet Hawk student-athletes with opportunities for post-season play as well as individual accolades. The university sponsors eight USCAA championship sports: men's and women's soccer, men's and women's cross country, men's and women's basketball, baseball and women's volleyball.

The Illinois Institute of Technology's women's lacrosse team is a member of the Midwest Women's Lacrosse Conference. Men's and women's swimming and diving programs compete in the Liberal Arts Conference.

Recreational Sports and Fitness

The department is committed to the well-being of the campus community through fitness activities and healthy competition. Programs are designed to make a positive contribution impacting personal, physical, ethical, and social development of the general student population.

Healthy and active lifestyles are also promoted through a varied menu of fitness classes, which are suggested by students. These range from high intensity interval training and hip hop dance classes to other popular activities. New classes are introduced each semester in order to provide maximum choice and variety for the student body.

Informal recreation and fitness activities on campus are also encouraged. Open swimming, the fitness center, and open gym in Keating provide students with drop-in options for activity. Illinois Institute of Techology has the only disc golf course in the city of Chicago, making the campus a popular destination for local disc golf enthusiasts.

Campus Life

iit.edu/campus_life

The Office of Campus Life provides campus programs and events designed to enhance the student educational experience outside of the classroom. The Office of Campus Life manages new student orientation (SOAR), the First Year Experience Program, leadership, service learning, and diversity-related programming. In addition, it also provides direct oversight to more than 125 student organizations including the Student Government Association and Union Board. Other registered student organizations (found at hawklink.iit.edu), represent a variety of student interests in areas such as culture, recreation, academics, and the arts.

Career Services

Hermann Hall, Suite 113
312.567.6800
web.iit.edu/career-services

Career Services is an on-campus resource for professional development and career planning. This office provides the following services to students and alumni:

- one-on-one and small group advising with career development coaches and peer career coaches
- reviews of résumés, cover letters, LinkedIn profiles, and other career-related documents
- professional development workshops for the general campus community and for specific student or alumni groups
- career fairs and other recruitment or networking events to engage with employers
- an internship and co-op program (including processing of Curricular Practical Training)

This office serves all current students and alumni from the following colleges/campuses: Armour College of Engineering, College of Architecture, College of Science, Institute for Food Safety and Health, Lewis College of Human Sciences, Pritzker Institute of Biomedical Science and Engineering, School of Applied Technology, and the Wanger Institute for Sustainable Energy Research (WISER). More information is available on the Career Services website.

Cooperative Education Program

Website: web.iit.edu/career-services/students/internships-and-co-ops

Cooperative education is a learning approach that integrates university studies with professional work experience in industry, business, or government. Salaries among Illinois Institute of Technology co-op students are competitive and help defray educational expenses. The co-op experience improves employment opportunities upon graduation. Graduate students must meet co-op and internship eligibility requirements.

Part-time employment opportunities are available for students both on and off campus. External, off-campus positions and Experiential Learning (EL), which are career-related co-ops and internships, are managed by Career Services. Students interested in and eligible for employment off campus in their field of study can receive job search assistance from Career Services. Appointments for individual career coaching may be made online. Students are encouraged to be a part of the university's Experiential Learning Program, which ensures that the internship or co-op experience is vetted and officially recognized by the university.

The EL program is a requirement for international students pursuing internships or co-ops under immigration rules and regulations. More information about off-campus employment and Experiential Learning is available on the Career Services website at careerservices.iit.edu.

On-campus positions, including federal work study and non-federal work study jobs, are managed through the Student Employment Office. More information is available on the Student Employment Office website at iit.edu/seo.

International students (on F-1 visa) are restricted to on-campus employment for their first academic year of study at any school in the United States. After completing one academic year in the country, students on an F-1 visa may be eligible for opportunities off campus (only if related to their field of study) through the Experiential Learning Program.

Policies for Graduate Students

- Graduate students enrolled in a summer co-op or internship on a full-time basis are not eligible to register for a course during the summer semester.
- Graduate students enrolled in a fall or spring co-op or internship on a full-time basis, for nine credits, and who are in good academic standing (cumulative GPA 3.0/4.0) may register for three to six credits of academic course enrollment, which is equivalent to 15 hours of registration.
- Graduate students who have earned academic probation, from the prior semester (cumulative GPA below 3.0/4.0) are not eligible to apply for a co-op or internship, for the first time, until the cumulative GPA is raised to 3.0/4.0.
- Graduate students who have earned academic probation, during a semester in which enrollment in a co-op or internship is concurrent with academic course registration, are not eligible for continued enrollment in a co-op or internship without prior approval of the Associate Dean for Graduate Academic A#airs.
- Graduate students, who are completing a second degree at Illinois Institute of Technology, when the first degree was also earned at IIT, are eligible for a co-op or internship, after one semester of full-time graduate enrollment, in a fall or spring semester.
- Graduate students, who are completing a second degree at Illinois Institute of Technology, when the first degree was earned at a different institution, are eligible for a co-op or internship after two semesters of full-time graduate enrollment, in fall and spring semesters.

Communication Across the Curriculum Program

iit.edu/cac

The Communication Across the Curriculum (CAC) Program helps students understand the role of writing and speaking in their academic and professional lives. Both on its website (iit.edu/cac) and through the IIT Writing Center, located in Siegel Hall 232/233/234, the CAC provides assistance in communication skills for academic inquiry, professional research, and the workplace. The CAC also assists instructors in developing materials relevant to written, oral, electronic, and interpersonal communication in discipline-specific courses—particularly Introduction to the Profession (ITP), communication-intensive courses (C-courses), and Interprofessional Projects (IPROs). The CAC director also administers the university's Basic Writing Proficiency requirement.

Commuter Student Services

Illinois Institute of Technology's commuter student organization, the Commuter Student Association, informs commuter students about available student services and serves as a place where commuter students get to know one another and voice their concerns. The group also plans a variety of events and activities throughout the year. The Bog, located in the lower level of Hermann Hall, is home to the Commuter Lounge during the weekdays. For more information on CSA's programming, students should contact the Office of Campus Life.

Disability Resources

iit.edu/cdr

Services for people with disabilities are coordinated by the Center for Disability Resources. People with disabilities who are interested in applying for admission to any of the university's academic programs are invited to call 312.567.5744 or email disabilities@iit.edu prior to their arrival on campus to discuss their individual needs. Enrolled students with disabilities are encouraged to contact the Center for Disability Resources to register and request accommodations.

Fraternity and Sorority Life

iit.edu/greek_life

The Greek community at the university is focused on giving students the chance to learn both inside and outside of the classroom. The university's seven fraternities and three sororities uphold their own missions through brotherhood and sisterhood activities. These groups also concentrate heavily on the values of their organizations by participating in regular philanthropic and community service events.
Each fraternity and sorority has its own operating structure and allows students to develop valuable leadership and interpersonal skills. Academics and scholarship are an integral part of the Greek system, and the community works hard to uphold rigorous scholastic standards as a part of their daily functioning. Membership is open to both residential and commuter students.

Graduate Academic Affairs

web.iit.edu/gaa

The Office of Graduate Academic Affairs (GAA) is responsible for the implementation and enforcement of graduate academic policies, the completion of academic standing reviews, degree audits and degree conferrals, communication with and counseling of graduate students, and the identification of campus resources, as appropriate to graduate student needs.

Idea Shop

ipro.iit.edu/ideashop

A catalyst for innovation, the Idea Shop is a 13,000-square-foot facility composed of a state-of-the-art rapid prototyping lab that includes 3D printers, CNC mills, electronics workstations and many hand fabrication tools; a Dell laptop lab; an iPad library; an iMac lab for mobile app development and video editing; collaborative teaming areas; and flexible open spaces. The Idea Shop is home to the university's Interprofessional Projects Program (IPRO) and entrepreneurship initiatives. The Idea Shop is located in the University Technology Park, a newly remodeled incubator space for researchers and companies requiring robust infrastructure.

The Idea Shop helps to build the competency and professional perspectives of Illinois Institute of Technology students at all levels. It is an inviting place for returning alumni, students, and prospective students to interact and participate in workshops. The Idea Shop also serves the Chicago-area entrepreneurial community and facilitates the process by transforming student and faculty generated ideas into actual businesses, products, and patents.

IIT Online

IIT Online is the bridge between academics and technology to deliver 21st century learning to Illinois Institute of Technology students. IIT Online supports departments in the design and delivery of online courses and programs. For specific online course or program details, the best source of information will always be the department offering the particular course or program.

The mission of IIT Online is to support faculty using educational technology in online, blended, or face-to-face instruction. This includes support for the university's learning management system (LMS), Blackboard, production services for lecture capture and video production, and student services for exam coordination.

Prospective students who wish to take courses or programs online must first be admitted to a degree, certificate, or professional development program. Students in online courses or programs are Illinois Institute of Technology students and are subject to the same policies and procedures as on-campus students in face-to-face courses.

Most online programs and courses are at the graduate level. Courses follow the same 16-week semester as the university academic calendar. Courses typically have the same faculty and follow the same syllabus. As such, course structure and delivery vary depending on the instructor. In most cases, online course content is created using recorded lectures of the corresponding face-to-face course, which are posted in Blackboard typically within a few hours of the face-to-face-session. Online and face-to-face course sections may share a Blackboard course shell, yet the sections are distinct: students enrolled in online sections are not counted when considering room assignments for courses or exams. If a course holds exams, exams follow the same university exam schedule. Exams are coordinated through IIT Online. Proctored exams are typically administered at local testing centers or online. Students are responsible for any additional third party fees associated with taking exams which may vary widely depending on the provider selected.

International Center

iit.edu/international-center

The purpose of the International Center is to promote international education and cultural exchange by supporting international students, faculty, staff, and students studying abroad; assisting in the compliance of immigration and other related regulations; providing study abroad advising for students interested in studying in another country; and providing services and resources to the university community.

These services include:

- Individual and group orientations to the university and community
- Assistance with document preparation for employment and other related non-immigrant benefits
- Workshops for faculty, staff, and students on issues affecting international students and scholars
- Cross-cultural activities and programs that promote intercultural perspectives and address adjustment issues
- Study abroad advising for students interested in studying in another country

All international students, scholars, and faculty are required to report to the International Center immediately upon arrival.

Interprofessional Projects

3424 South State Street
Central Building, 4th Floor
ipro.iit.edu

Since its beginning in 1995, IPRO has brought together students and faculty of all disciplines to research issues, define problems, and develop real-world solutions. All undergraduate students are required to take 6 credit hours of IPRO courses, which provide hands-on experience in real-world, challenging projects. Generally, undergraduate students take these courses during the second through fifth year of study. Each IPRO course is a unique project with teams that include the faculty and enrolled students. IPRO courses encourage intellectual inquiry with research on the project subject, analysis, design, and development. Professional ethics, writing, teamwork, communication, and presentations round out the IPRO learning objectives. IPRO projects are intended for students to gain knowledge that goes beyond the traditional classroom experience.

Libraries

library.iit.edu

Illinois Institute of Technology's libraries include Paul V. Galvin Library; the Center for the Study of Ethics in the Professions (Mies Campus); the Graham Resource Center (Mies Campus); the Chicago-Kent College of Law Library (Downtown Campus); the Institute for Food Safety and Health Library (Moffett Campus); and University Archives and Special Collections (UASC) (Mies Campus).

Paul V. Galvin Library

312.567.5318
library.iit.edu

As the university's central library, Paul V. Galvin Library combines digital access with traditional library services. The library's physical holdings include more than one million volumes and library spaces that accommodate both individual and collaborative learning. Computers, printers, scanners, copiers, and 3-D printers are available for patrons. Virtual services are provided 24 hours per day with access to online databases indexing millions of journal articles, from approximately 62,000 full text e-journals, more than one million e-books, and I-Share, a statewide resource sharing system of more than 85 academic libraries. Galvin Library also provides web-based delivery of materials including documents requested via interlibrary loan. The library's instruction program serves the university community by teaching skills needed to locate, retrieve, and evaluate information. Library instructors teach at all levels from introductory to advanced, cover a broad range of information and retrieval techniques, and subject specialists can specifically tailor instruction sessions. The library also manages and maintains an institutional repository.

Graham Resource Center

312.567.3256
library.iit.edu/grc

Housed in Crown Hall, the Graham Resource Center (GRC) is the university's architecture library, serving students and faculty of the College of Architecture (COA), and a branch of Paul Galvin Library. The GRC supports the educational and curricular goals of the COA by acquiring, preserving, and serving materials in various media to COA students, faculty, and staff; providing reference and research assistance to patrons about architecture, landscape architecture, and city planning, and offering bibliographic instruction to all GRC and architecture researchers and users.

The collections of the Graham Resource Center includes more than 15,000 books, 40 journal titles, and many electronic resources to meet research and reference needs. The GRC also holds special collections focused on Mies van der Rohe and Chicago architecture, as well as a circulating collection of iconic chairs.

Center for the Study of Ethics in the Professions

312.567.6913
ethics.iit.edu

The center, located in Hermann Hall, contains a variety of materials dealing with professional and applied ethics, as well as how ethical and social issues arise in scientific research and emerging technologies. Home to the Ethics Codes Collection, the largest collection of codes and ethics and guidelines in the world, the library provides bibliographic assistance to students and researchers and assists visiting scholars and practitioners.

Chicago-Kent College of Law Library

312.906.5600
kentlaw.iit.edu/library

The law library at the Downtown Campus serves Chicago-Kent College of Law and other university programs taught at the downtown facility. The law library is one of the largest in the country, with more than 500,000 volumes of legal materials covering federal, state, local, and international jurisdictions. The law library is a depository for U.S. Federal, United Nations, and European Union materials. The law librarians provide research and instructional assistance to faculty and students of the Downtown Campus, as well as tours and instruction to others who use the law library. Special collections include the Library of International Relations, the Law School Archives, and the Law School's growing institutional repository.

Institute for Food Safety and Health Library

708.563.8160
library.iit.edu/ifsh

Located on Illinois Institute of Technology's Moffett Campus in Bedford Park, the branch library at the Institute for Food Safety and Health (IFSH) supports both the academic curriculum for the Department of Food Science and Nutrition, and the food safety and technology research being conducted at IFSH.

A depository library for the FAO (Food and Agriculture Organization of the United Nations), the library provides digital access to all of the Galvin Library's databases, as well as services such as interlibrary loan, web-based document delivery, and library instruction.

University Archives & Special Collections

312.567.6840
archives.iit.edu

Part of the Paul V. Galvin Library, University Archives & Special Collections (UASC) holds materials relating to every aspect of Illinois Institute of Technology's history, including non-current university records, papers of faculty members, alumni, and student organizations; publications, photographs, audiovisual materials, artifacts, and more. UASC holdings are non-circulating, and no special credentials or permissions are necessary to use the materials; UASC is open to the Illinois Institute of Technology community and general public for research and reference use. UASC staff are also able to assist students, faculty, and staff with archival research, and are available for classroom instruction sessions using primary source materials. Holdings can be searched at archives.iit.edu.

Office of Inclusion, Diversity, and Employer Engagement

312.567.3777
scdi@iit.edu
iit.edu/scdi

The Office of Inclusion, Diversity, and Employer Engagement (IDE^2) serves as a catalyst to connect individuals and communities through shared learning and collaborative action in order to develop self-sustainable partnerships. These partnerships allow the university, community, and company stakeholders to research current trends, legislature, and practices that support co-creation, which is imperative to building cultural confidence and encouraging mutual respect.

Finally, we seek to pioneer, accelerate, incubate, and provide a safe place for new ventures and ideas to deliver breakthrough results for the students, staff, faculty, alumni, and stakeholders we serve in support of the Many Voices One Vision strategic plan of the university as articulated by the president and provost of the university.

The office is guided by five core values that shape our approach to diversity, inclusion, and employer engagement at Illinois Institute of Technology.

Core Values

Experiential and Reflective Learning

We are committed to supporting lifelong learning, which is best achieved through hands-on interaction coupled with intentional reflection. This practice provides an opportunity for students, scholars, companies, and community members to explore cultural practices and traditions, academic disciplines, and personal experiences. Through this process we also learn about our own values and strengths, deepening our ability to promote and take intentional action.

Collaboration and Commitment

We are committed to addressing the complex career challenges that our diverse student body is facing and progress can only be achieved through meeting the needs of scholars as an individual. Our work relies heavily on relationships with companies, community partners, students, staff, faculty, and alumni. These relationships take time to build and require continuous investment and renewal. We are committed to the process required for successful collaboration and seek to form communal partnerships to make long-term sustainable differences.

Shared Wisdom

We are committed to respecting imagination world-wide. Universal wisdom comes from lived experiences and everyone can serve in the role of teaching. We rely on a variety of shared wisdom to help us identify comfort zones, and we value our corporate and community partners as co-educators who support student learning in ways the classroom cannot.

Student Engagement

We are committed to enlightening and empowering students, so that they can take action. Students can use their honored position to serve others and contribute to broader movements for engagement. We value student passions, talents, ideas, and experiences and believe in their capacity to be successful change agents and leaders on and off campus.

Embrace and Drive Change

We are committed to servicing the diverse needs of everyone. Societal structures tend to privilege the majority and the powerful. Without the intentional actions of individuals, the needs of those with fewer resources are overlooked. We believe that there are enough resources to meet the basic needs of all, and to enable each person to live a full life with dignity. Illinois Institute of Technology has a responsibility to promote and introduce respectful and compatible career opportunities.

Signature Programs

- Illumination Sessions
- Orientation on Career Culture and Ethics
- Diversity Career Connections
- Diversity Research Scholars (DRS)
- Veterans Legacy Career Assistance
- Graduation Parent Pinning Reception

Projects

- The Wild Formula
- National Career Development Month

One Stop

312.567.3810
onestop@iit.edu
onestop.iit.edu

The One Stop has been established to provide services to students with maximum efficiency and a minimum of confusion. This office, representing the offices of the Registrar, Financial Aid, Academic Affairs, and Student Accounting will be the starting point for all university students (prospective, new, and continuing) seeking administrative and academic assistance.

At the One Stop, students can get assistance, ask questions, and be pointed in the right direction for registration, change of major, student petitions, enrollment verification, transcripts, and more. Students can get personal assistance with financial account information, paying tuition and fees, housing bills, and parking tickets, as well as obtaining information about financial aid. For more details, see onestop.iit.edu or call 312.567.3810.

Registrar

312.567.3100
registrar@iit.edu
iit.edu/registrar

The Office of the Registrar serves as the official data steward of institutional academic information and student records to support the needs of students, faculty, staff, and alumni at Illinois Institute of Technology. The office maintains accurate, timely, and secure information to support and enforce academic policy, registration, grading, enrollment and degree certification, course information, the production of diplomas and official transcripts, and other related university functions.

Residence and Greek Life

312.567.5075
housing@iit.edu
iit.edu/housing

On-campus housing is available to both undergraduate and graduate students. First-year students not living with their parents or guardians within a 50-mile radius of campus are required to live in the residence halls. Family housing is provided for students who are married, living with a domestic partner, or have a legal guardianship of a dependent. Students living in the residence halls are eligible for a variety of meal plans. Required participation in a meal plan varies based on room assignment.

Residence and Greek Life (RGL) offers a wide range of accommodations, programs, and services designed to enhance campus life. Housing options vary from single rooms to fully furnished apartments with kitchens. RGL maintains residence halls and sorority houses designed to meet the different needs of students. Within these buildings, professional and paraprofessional staff coordinate academic and social programming, provide leadership opportunities to residents, and assist students with personal and academic concerns.

To learn more about on-campus housing options, please contact Residence and Greek Life at housing@iit.edu or visit the website at iit.edu/housing.

Spiritual Life and Diversity

Office of Spiritual Life and Diversity
MTCC 213
Director: 312.567.3160, slds@iit.edu
web.iit.edu/campus-life/diversity-and-inclusion

Part of the Office of Campus Life, Spiritual Life and Diversity serves students of all backgrounds, both religious and secular, and works to foster a safe and inclusive campus for the entire Illinois Institute of Technology community. The office provides programs, advocacy, and advice on issues, policies, and practices as they relate to the university's commitment to diversity and inclusion. Our work addresses religion, race, gender, sexual orientation, and immigration status. Additionally, the director is available to discuss personal or spiritual issues.

Student Affairs

312.567.3081
dos@iit.edu
iit.edu/student-affairs

The Office of Student Affairs oversees many areas of student life and serves as the primary advocate and ombudsperson for students. The office also manages the student conduct process. Students, faculty, and staff are encouraged to contact the office for help or referrals.

Activities outside the classroom and laboratory complement and enhance the university's central educational mission. Illinois Institute of Technology encourages all students to participate in athletics, student organizations, and professional societies. Students are also encouraged to take advantage of the cultural, educational, and recreational resources on campus, as well as in the Chicago area. For additional information on activities, organizations, and services, consult the Student Handbook.

Student Employment Office

312.567.6802
seo1@iit.edu
studentemployment.iit.edu

The Student Employment Office (SEO) oversees all aspects of on-campus employment for students and their faculty and staff supervisors, including hiring processes and best practices, to provide students with meaningful and professional on-campus employment experiences. This office establishes policies and procedures, develops resources for student employment training and evaluation, and enforces compliance with institutional policies and federal regulations. See the Student Employment website for more information: studentemployment.iit.edu.

Student Health and Wellness Center

IIT Tower, 3rd Floor
Appointments: 312.567.7550
student.health@iit.edu
iit.edu/shwc

The Student Health and Wellness Center (SHWC) provides quality and cost-sensitive healthcare tailored to the needs of our students. The goal of SHWC is to provide campus health and wellness resources that enable students to successfully achieve their academic goals and promote lifelong wellness. The SHWC provides primary care and counseling services, as well as oversees the student health insurance plan and immunization compliance.

SHWC provides diagnosis and treatment of common illnesses and injuries with the ability to dispense medication and/or provide appropriate prescriptions. Immunizations, allergy injections, gynecological care, sexual health screening, and walk-in urgent care are also provided. A small fee may incur for labs, diagnostic tests, immunizations, and medication given on site.

The SHWC provides administrative oversight of the Aetna Student Health Insurance Plan offered to students registered for one or more credit hours. Health insurance is not required to use the SHWC. Counseling services include psychotherapy, referral, and medication management. Treatment length varies depending on individual needs. The SHWC also offers group therapy. Counselors are experienced to address many issues students may face including, but not limited to, loneliness, relationship concerns, family issues, self-esteem, depression, anxiety, concentration difficulties, sleeping difficulties, eating disorders, addiction, sexual concerns, anger management, cultural adjustment, and other personal issues.

The SHWC team of culturally sensitive professionals provides comprehensive clinical services and outreach programs to students. In addition, SHWC is a resource for consultation to faculty, staff, and parents.

Technology Commercialization

The Office of Intellectual Property and Technology Transfer supports all Illinois Institute of Technology efforts to build and sustain relationships with corporations and other external organizations. The office coordinates the process of identifying, evaluating, protecting, marketing, and licensing all university inventions and copyrightable material. Assistance with business startup issues is available. Herb Munsterman, Director, can be reached at 312.906.5259 or hmunster@kentlaw.iit.edu.

Technology Services

Support Desk: 312.567.3375
supportdesk@iit.edu
iit.edu/ots

The Office of Technology Services (OTS) supports Illinois Institute of Technology's primary technology systems, including administrative systems, MyIIT, Banner, and the network and telephone infrastructures. OTS maintains approximately 500 computers in its classrooms, labs, and public terminals throughout the Mies, Downtown, Rice, and Moffett Campuses, including an online Virtual Computer Lab, which enables students to schedule an ad hoc connection to the most frequently used academic lab software from their own devices, including laptops and tablets, at any time, from any location. To ensure that students have access to equipment that support their academic goals, OTS offers laptop and MiFi-device checkout at the Galvin Library and Support Desk. Additionally, the computers in the classrooms and labs are refreshed on a three-year cycle. OTS also supports remote printing from personal laptops/desktops and mobile devices to printing release stations located in various computer labs and public areas. Additional information about these services is available on the OTS website.

OTS manages the MyIIT portal, which provides personalized access to email, Google Apps, online course registration, Blackboard, OTS Support, student financial information, student life, weblinks, tools, and other content. All Illinois Institute of Technology students receive an email address integrated into each student's Google Apps for Education account, which is accessed via the MyIIT portal. Google Apps for Education also includes collaboration tools such as Google Docs, Sites, Groups, and more. Supplemental class materials are available through Blackboard, IIT's course management system, where instructors post lectures, notes, and other course information. Blackboard Learn, Community, and Collaborate are also available to enhance students' learning experience. IIT distance learning content and video lectures are also accessed through Blackboard.

With the assistance of the Illinois Institute of Technology Student Government Association, OTS has recently deployed a free mobile app for current students, named HAWKi, which puts many useful resources at students' fingertips. Students can: (1) view course assignments, class rosters, grades, discussions, and class announcements, and updates; (2) view their course schedules and sync them with their mobile devices' calendars; (3) check out the latest events happening on campus; and much more! The app will continue to change and grow in the coming years to reflect students' needs and desires.

The OTS Support Desk is the central point of contact for technology support at the university. Support Desk staff provide technical troubleshooting, account management, and configuration assistance for all students, faculty, and staff. OTS Support is available through the MyIIT portal and includes a knowledge database with how-to information for common technical issues and questions. A request for technical support may be submitted by opening a ticket through the OTS website, sending a request via email (supportdesk@iit.edu), or by calling the Support Desk at 312.567.3375.

The university provides traffic-shaped Internet access through its wired and wireless networks. Most campus buildings have wired Internet access and secured wireless Internet access is available campus-wide. Visit the OTS website to view the university's current WiFi zones. Instructions for connecting to the Internet through the university network, including how to configure and register personal computers and mobile devices, are also available on the OTS website.

Visit the OTS website for the most up-to-date information and useful details about the university's technology.

Undergraduate Academic Affairs

312.567.3300
ugaa@iit.edu
iit.edu/ugaa

The Office of Undergraduate Academic Affairs (UGAA) provides a variety of academic support services for all undergraduate students from the time of admission to graduation. These services include academic advising; evaluation of transfer credits from both United States and international schools; academic program audits; student petitions; course repeats for a change of grade; change of major; monitoring of academic progress; certification of student's eligibility for degree conferral; granting an official leave of absence; and official withdrawal from the university. In addition, this office reinstates former undergraduate students to the university and maintains the official academic files for all undergraduate students. Degree Works, the online degree audit system, is monitored and maintained by the Office of Undergraduate Academic Affairs.

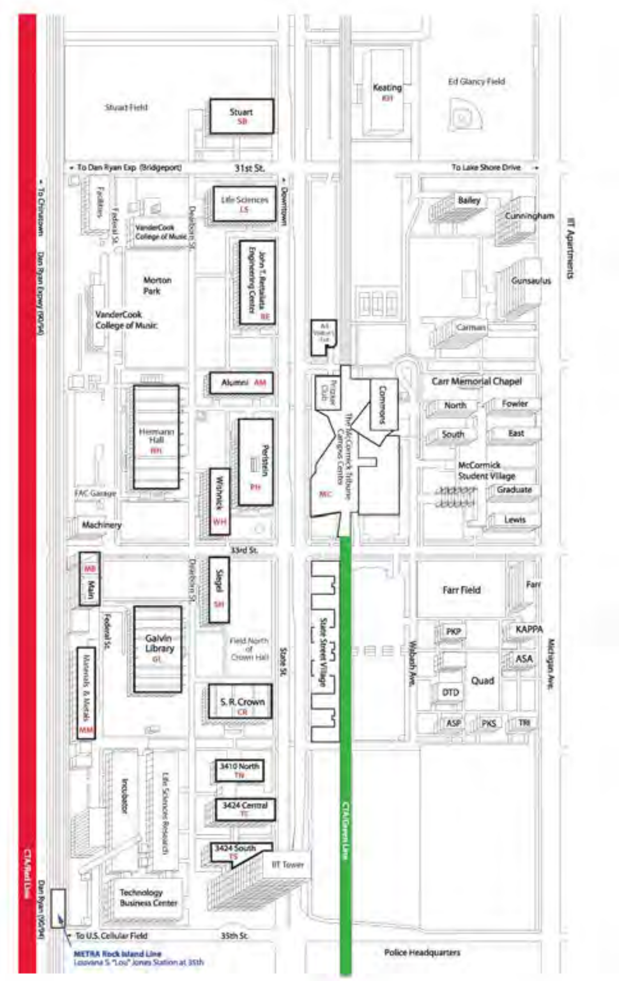
Writing Center

Siegel Hall 232/233/234
humansciences.iit.edu/humanities/writing-center

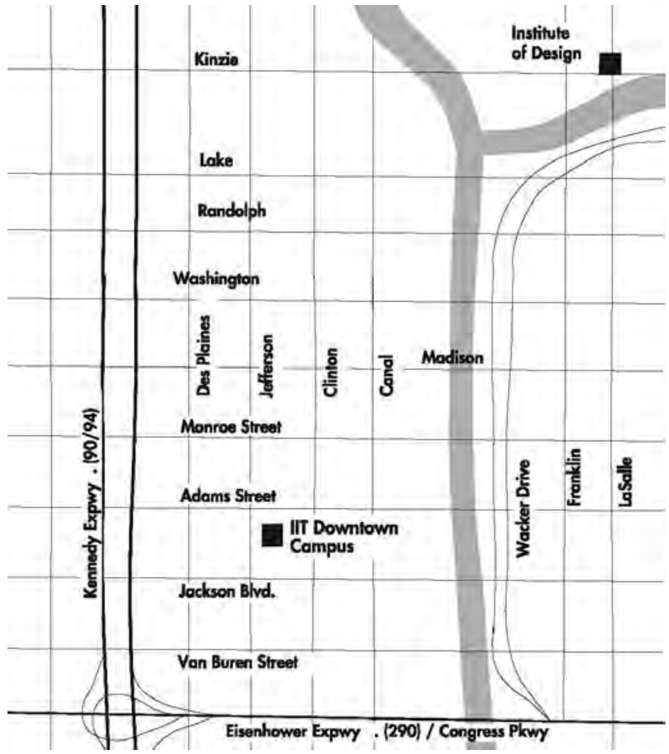
Students can seek assistance with written and oral assignments at the IIT Writing Center, located in Siegel Hall 232/233/234. Tutors are available to assist students enrolled in writing-intensive courses (Introduction to the Profession, C-courses, and IPROs). Tutors specializing in English as a Second Language are also available to assist students whose primary language is not English. Appointments can be made in advance on the sign-up sheets on Siegel 232/233/234 doors. Walk-in appointments are also possible when tutors are not working with other students. Tutoring is free of charge, and both undergraduate and graduate students are welcome.

MAPS

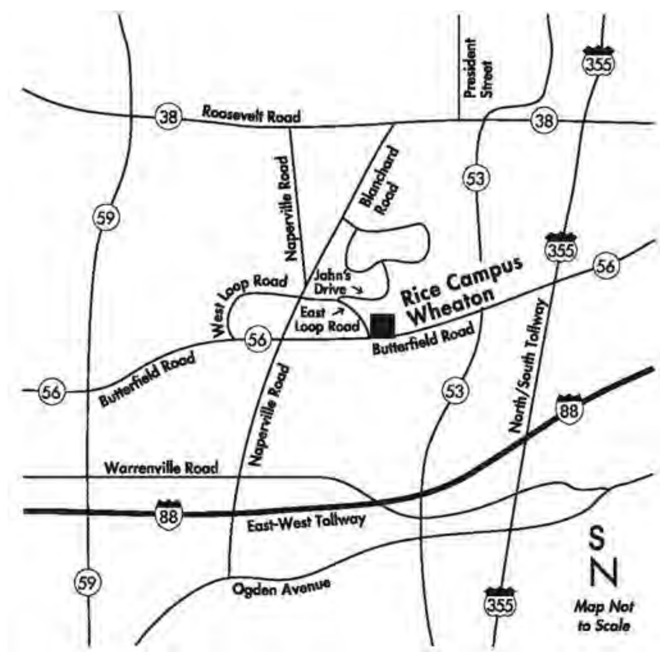
Mies Campus



Downtown Campus and Institute of Design



Rice Campus



Directions

Getting to Mies Campus

Airports

Illinois Institute of Technology and Chicago are served by O'Hare International Airport and Midway International Airport. Public and private transportation is available from the airports to downtown Chicago and the university campuses.

Train

Metra Rail Rock Island District line to 35th Street/Lou Jones/ Bronzeville station.

Other commuter railroad lines to Union and Northwestern train stations (both off Canal Street), then public transportation, taxi, or IIT shuttle bus from the Downtown Campus at 565 West Adams Street to Mies Campus.

Bus

To Greyhound or Continental Trailways terminal, then taxi or public transportation to the university.

Public Transportation

1. CTA Red Line (Howard-Dan Ryan) to 35th Street Station.
2. CTA Green Line (Lake-Englewood-Jackson Park) to 35-Bronzeville-IIT station.
3. CTA bus lines with stops on State Street (#29) or Michigan Avenue (#35).

Automobile

From North: Dan Ryan Expressway east to 31st Street exit, continue south to 33rd Street, turn left (east). Metered parking is located along Federal Street north and south of 33rd Street, and in the Visitor's Parking Lot (Lot A4) at 32nd Street and State Street, on the east side of State Street.

From South: Dan Ryan Expressway west to 35th Street exit, continue north to 33rd Street, turn right (east). Metered parking is located along Federal Street north and south of 33rd Street, and in the Visitor's Parking Lot (Lot A4) located at 32nd Street and State Street, on the east side of State Street.

From Lake Shore Drive: Exit at 31st Street, go inland (west) to State Street, turn left (south). Metered parking is available in the Visitor's Parking Lot (Lot A4) located at 32nd Street and State Street, on the east side of State Street.

Parking

Pay station parking is available to all visitors and is located in designated lots on State Street between 31st and 35th streets. Special event parking may be available in other parking lots on campus. Please contact the Access, Card, and Parking Services Office for more details on parking, or visit the parking web page for current parking locations at web.iit.edu/acaps/parking. Please call the parking administrator at 312.567.8968 if you need assistance in finding parking.

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