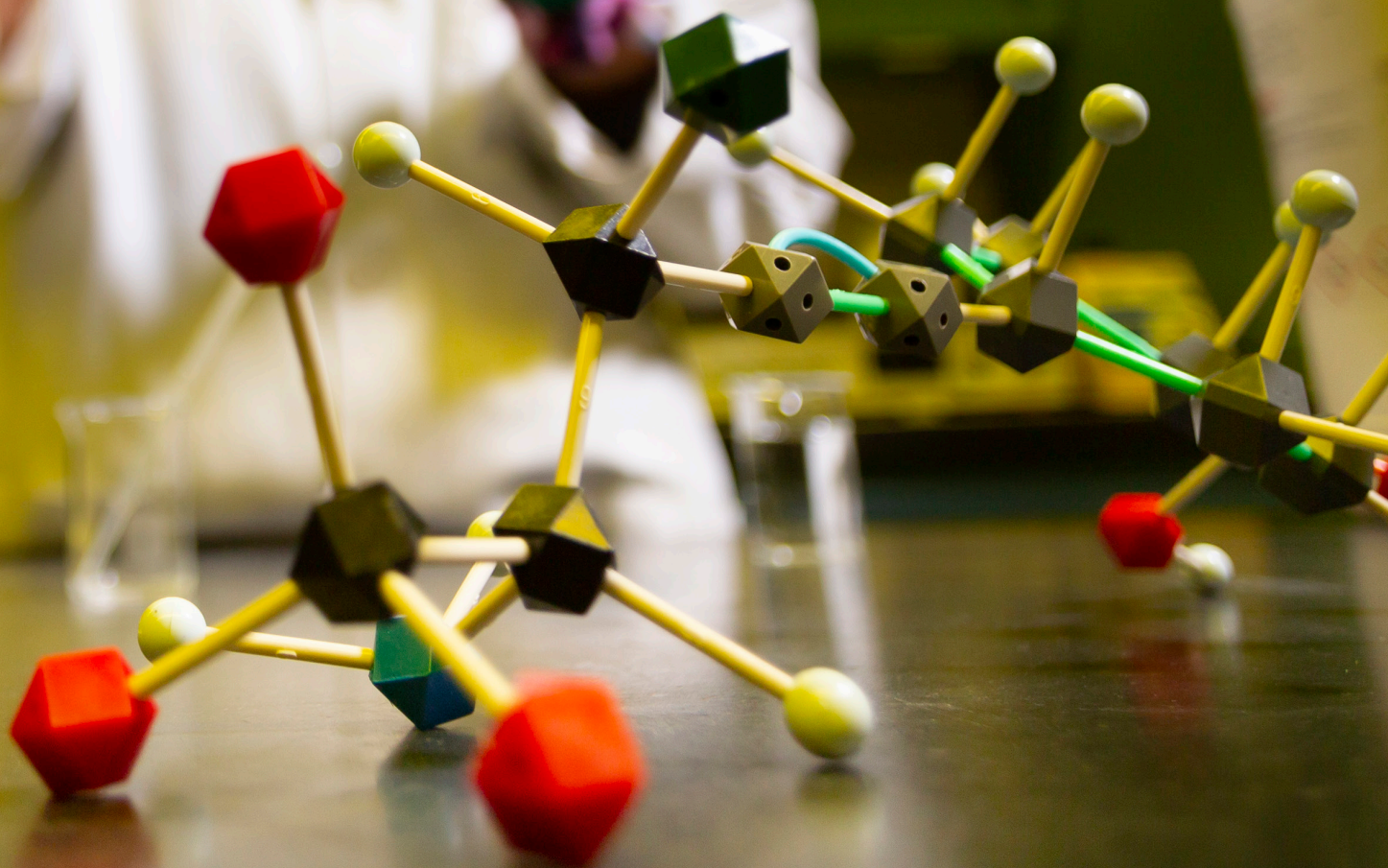


Bulletin

Graduate Programs
2020–2021



ILLINOIS TECH

Discover. Create. Solve.

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FOREWORD

ILLINOIS TECH EXPRESSLY RESERVES THE RIGHT, AT ITS SOLE DISCRETION, TO REVIEW AND TO MODIFY THE REGULATIONS, POLICIES, PROCEDURES AND REQUIREMENTS SET FORTH IN THIS BULLETIN AT ANY TIME AND FOR ANY REASON, WITHOUT PRIOR NOTICE OR CONSULTATION OR CONSIDERATION OR LIABILITY OF ANY KIND. TO BE CLEAR, THIS INCLUDES THE MEANS AND METHODS BY WHICH INSTRUCTION IS DELIVERED. ANY SUCH CHANGES WILL BE PUBLISHED IN THE WEB VERSION OF THIS BULLETIN WHICH CAN BE FOUND AT <http://bulletin.iit.edu>, AND ANY SUCH CHANGES SHALL BECOME EFFECTIVE UPON PUBLICATION. THE VERSION OF THIS BULLETIN SO POSTED ON THE WEBSITE SHALL BE DEEMED, FOR ALL PURPOSES, THE MOST CURRENT VERSION, AND IT SHALL GOVERN AND CONTROL IN ALL INSTANCES, MEANING THAT IN THE EVENT OF A CONFLICT BETWEEN ANY PRINTED VERSIONS OF THIS BULLETIN OR ANY EARLIER POSTED VERSIONS OF THIS BULLETIN AND THE THEN-CURRENTLY POSTED VERSION OF THIS BULLETIN ON THE WEBSITE, THE CURRENTLY POSTED VERSION OF THIS BULLETIN ON THE WEBSITE SHALL GOVERN AND CONTROL.

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 (Illinois Tech) in the academic year 2020-2021. 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 they have 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, National Architectural Accrediting Board, and the Landscape Architectural Accreditation 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)

Peter Kilpatrick, Provost and Senior Vice President for Academic Affairs

Office of the Provost (web.iit.edu/provost)

John F. O. Bilson, Dean, Stuart School of Business

Kenneth T. Christensen, Dean, Armour College of Engineering

Lance Fortnow, Dean, College of Computing

Christine Himes, Interim Dean, Lewis College of Science and Letters

Reed Kroloff, Dean, College of Architecture

Anita K. Krug, Chicago-Kent College of Law

Denis Weil, Dean, Institute of Design

Academic Calendar

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

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

Graduate Academic Affairs

Website: web.iit.edu/gaa

Jamshid Mohammadi, Dean of the Graduate College and Vice Provost for Graduate Academic Affairs

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 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, oversees curricula management and thesis examination.

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, oversees degree certification and enforces co-terminal and graduate studies policies.

Thirty-six 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-two separate offerings. Doctoral (Ph.D.) degrees are offered in twenty-two 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 at Illinois Tech 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
 Sustainable Transportation and Infrastructure Research Center (STAIR)
 Electric Power and Power Electronics Center (EPPEC)
 Engineering Center for Diabetes Research and Education (ECDRE)
 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 Technology Development (OTD)

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 László 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 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 Technology Park is now home to many companies.

Today, Illinois Tech is a private, technology-focused, Ph.D.-granting research university—the only university of its kind in Chicago. Its Chicago location offers students access to the world-class resources of a great global metropolis. It offers undergraduate and graduate degrees in engineering, science, architecture, business, design, human sciences, applied technology, and law. One of 21 institutions that comprise the Association of Independent Technological Universities (AITU), Illinois Tech provides an exceptional education centered on active learning, and its graduates lead the state and much of the nation in economic prosperity. Illinois Tech uniquely prepares students to succeed in professions that require technological sophistication, an innovative mindset, and an entrepreneurial spirit.

The university has four 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

Enrollment (Fall 2019)

Undergraduate	3,026 students
Graduate	2,845 students
Law	882 students
Continuing Education	87 students
Total	6,840 students

Student Demographics

Male	63%
Female	37%
Minority ¹	16%
International	42%
Countries of Origin	93
Student/Faculty Ratio	12:1

Degrees Awarded 2018-2019

Bachelor	559
Master	1,670
First Professional	234
Ph.D.	92
Certificates	11
Total	2,566

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

GRADUATE ADMISSION

Application for Admission

The online application form and additional information for degree, certificate, and non-degree admission are found at admissions.iit.edu/graduate.

All documents submitted in support of an application must be original documents, or copies of original documents provided by the issuing university. Documents provided as part of the online application may not be duplicated, transferred, forwarded, or returned once they have been submitted. A non-refundable application fee is also required. Applications, fees, instructions, and additional information are found at admissions.iit.edu/graduate. Any current or former Illinois Tech student is not required to submit an application fee.

Students may defer their admission for up to one academic year from their originally admitted term. Students must contact the Office of Graduate Admission and request to defer their admission. Students wishing to register more than one year after the initial application must apply as a new student and resubmit all documents and fees.

Students applying to the Stuart School of Business, Chicago-Kent College of Law, Institute of Design, Department of Psychology, or College of Architecture should visit their respective websites for information on deadlines and additional requirements:

- For additional information on Stuart School of Business graduate programs, visit stuart.iit.edu or call 312.906.6500.
- For additional information on Chicago-Kent College of Law graduate programs, visit kentlaw.iit.edu or call 312.906.5020.
- For additional information on Institute of Design graduate programs, visit id.iit.edu or call 312.595.4900.
- For additional information on Psychology graduate programs, visit iit.edu/psychology or call 312.567.3020.
- For additional information on College of Architecture graduate programs, visit arch.iit.edu or call 312.567.3260.

Degree-Seeking Versus Non-Degree Status

A degree-seeking student holds an undergraduate degree from an accredited institution, has applied for admission to a degree-granting program (master or doctoral level), has been admitted by an academic unit in a specific degree program, and has received a formal letter of admission. Degree-seeking students are required to register every semester, except summer, unless they are granted an official leave of absence from the Office of Graduate Academic Affairs (see the Leaves and Withdrawals section (p. 570) of this bulletin for more information).

A non-degree student holds an undergraduate degree from an accredited institution, has applied for admission to a non-degree-granting program, and has been admitted by a specific academic unit. Non-degree students generally wish to improve their professional or personal skills without being required to fulfill degree requirements, are uncertain about their prospective field of study, or possess credentials that do not meet the minimum requirements for degree-granting programs. Non-degree students are not classified as degree-seeking students, and are not awarded a degree unless they reapply for degree-seeking status (see below for procedures on becoming a degree-seeking student).

Admission as a Degree-Seeking Student

To apply for degree-seeking admission, prospective students should submit an online application, including all required documents, required test scores, and the application fee, prior to the published deadlines. Applications received after the final deadline may be deferred for consideration to the next admitting term. U.S. citizens, permanent residents, eligible non-citizens and residents, and international students must submit the following:

1. Official transcripts, or copies of official transcripts, for all post-secondary coursework
2. Professional statement
3. Required test scores
4. Letters of recommendation
5. Resume (Stuart School of Business and Clinical Psychology applicants only)
6. Application fee

International applicants must also submit the following (see Additional International Applicant Requirements (p. 13) for more information):

1. English proficiency test scores
2. Financial affidavit of support
3. Passport identity page
4. SEVIS transfer form (only for students with active SEVIS IDs in the United States)

The required minimum cumulative undergraduate GPA for degree-seeking 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. 12).) Official documents issued by the relevant university, or copies of official documents issued by the relevant university, must be provided for any attempted or completed post-secondary coursework. These documents should include any failed, reattempted, or repeated courses.

Professional statements are usually two to three pages in length, and detail an applicant's academic or professional experience, plans after graduation, and/or interest in research projects conducted by Illinois Tech faculty.

All applicants are required to submit official exam scores as required by their program of interest. For programs accepting the GRE general exam, a minimum composite score of 292 (quantitative + verbal) and 2.5 (analytical writing) is required for professional master's and master of science applicants. Doctoral minimum GRE composite score requirements are 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, and should be reported to Illinois Tech using code 1318. The GRE requirement may be waived for applicants to professional master's programs with a bachelor's degree from an accredited U.S. college or university and cumulative undergraduate GPA of at least 3.0/4.0.

Applicants to Chicago-Kent College of Law must submit LSAT scores as required. Stuart School of Business applicants must submit GMAT or GRE as required. 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.

Letters of recommendation are required for doctoral applicants, and strongly encouraged for master of science and professional master's applicants. Applicants may submit up to three letters of recommendation from professional or academic sources who are able to assess applicants' skills and preparedness of graduate study. Recommendations from personal friends or family members are not accepted.

Resumes are only accepted for applicants to Stuart School of Business graduate programs, and the Ph.D. in Psychology, specialization in Clinical Psychology program. Resumes are not accepted for applicants to other programs or study.

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. Admitted students may be required to take additional prerequisite courses which may not count towards the degree.

Admission as a Certificate Student

To apply for certificate program admission, prospective students should submit an online application, including all required documents and the application fee, prior to the published deadlines. Applications received after the final deadline may be deferred for consideration to the next admitting term. U.S. citizens, permanent residents, eligible non-citizens and residents, and international students must submit the following:

1. Official transcripts, or copies of official transcripts
2. Application fee

The required minimum cumulative undergraduate GPA for certificate admission is 2.5/4.0. Official documents issued by the relevant university, or copies of official documents issued by the relevant university, must be provided for any attempted or completed post-secondary coursework. These documents should include any failed, reattempted, or repeated courses. For more information about certificate program eligibility, refer to the Certificate Conferral section (p. 569) of this bulletin.

Certificate students who reapply to a degree-granting program may apply only *approved* certificate coursework with at least a "B" average to the degree. Students should also refer to the section on Transfer Credit (p. 560).

Meeting the minimum required 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. Admitted students may be required to take additional prerequisite courses which may not count towards the degree. Certificate students are permitted to enroll in as many credit hours as are necessary to complete the certificate.

Admission as a Non-Degree Student

To apply for non-degree admission, prospective students should submit an online application, including all required documents and the application fee, prior to the published deadlines. Applications received after the final deadline may be deferred for consideration to the next admitting term. U.S. citizens, permanent residents, eligible non-citizens and residents must submit the following:

1. Official transcripts, or copies of official transcripts
2. Application fee

The required minimum cumulative undergraduate GPA for non-degree admission is 2.5/4.0. Official documents issued by the relevant university, or copies of official documents issued by the relevant university, must be provided for any attempted or completed post-secondary coursework. These documents should include any failed, reattempted, or repeated courses.

Non-degree students who reapply to a degree-granting program may apply up to nine credit hours for approved coursework with at least a "B" average to the degree. Students should also refer to the section on Transfer Credit (p. 560).

Meeting the minimum required 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. Non-degree students are permitted to enroll in as many credit hours as they wish, but may only apply a maximum of nine credit hours for approved coursework with at least a "B" average to the degree.

International students may not apply for non-degree study, and cannot be granted an I-20 or an F-1 visa for non-degree study.

Additional International Applicant Requirements

International students applying for admission to degree-seeking or certificate programs must submit the following requirements, in addition to any requirements outlined in the relevant sections of this bulletin:

1. English proficiency test scores
2. Financial affidavit of support
3. Passport identity page
4. SEVIS transfer form (only for students with active SEVIS IDs in the United States)

If the post-secondary institution(s) does not issue official transcripts in English, both the original and a professional English translation are required. We recommend an American Translators Association (ATA) translator (atanet.org). If the prior institution does not use the 4.0 scale grading system, the Office of Graduate Admission will evaluate your grades with respect to that system upon review of your transcripts. In the case that we are unable to evaluate and interpret credentials, applicants must have their documents professionally evaluated. Applicants must use Educational Credential Evaluators or Educational Perspectives. Professional evaluations along with official, original documents should be uploaded with the application.

Students whose primary language is not English, or whose undergraduate curricula were not taught exclusively in English, must submit a valid TOEFL, IELTS, Duolingo or PTE score report to Illinois Tech using code 1318. These scores are considered valid for two years from the test date. If your scores are more than two years old at the time of your application submission, you must provide new scores. For minimum score requirements, please see English Proficiency Requirements. Waivers are available for students whose primary language is English, or whose undergraduate curricula were taught in English as noted on their official transcript(s). Students must receive at least two years of English-medium instruction from a degree-granting program to qualify for a waiver.

The financial affidavit of support is required for admitted students to receive their I-20 or DS-2019—documents used to secure the appropriate visa for studying in the United States. In accordance with federal regulations, students must demonstrate financial resources needed for at least one academic year of tuition and estimated living expenses for the academic year of entry. Any scholarships or assistantships awarded by Illinois Tech, the Office of Graduate Admissions, or by admitting university faculty, as well as any private, employer, or governmental based scholarships and sponsorships may be deducted from the amount a student is required to provide in their financial affidavit of support. Students may provide this documentation at the time of application, or after any offer of admission is made.

The passport identity page is used to verify applicants' full names, birthdates, and national origin before providing immigration documents. This allows documents to be processed more quickly and more accurately.

The SEVIS transfer form is only used for international students currently in the United States on an active F-1 visa in good standing wishing to transfer their existing SEVIS ID to Illinois Tech from their current university or institution in the United States. This form must be completed if an international student wishes to retain their current SEVIS ID, and will require assistance from an international students adviser at their current university. This must be completed and returned before a new I-20 using that existing SEVIS ID can be generated.

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. Admitted students may be required to take additional prerequisite courses which may not count towards the degree.

Certification of Official Transcripts

Completion and conferral of a graduate degree requires degree-seeking admission to Illinois Institute of Technology (Illinois Tech), and prior completion of the prerequisite degree requirement, as outlined in the current Graduate Bulletin. Admitted graduate students are required to have earned the prerequisite degree(s) prior to enrollment, and to present certification of the earned degree(s) before completing any graduate degree at Illinois Tech. Students who have completed an undergraduate degree at Illinois Tech may be exempted from the degree certification policy at the discretion of the Office of Graduate Admission.

Degree certification will be completed at the time of admission, if the required documents have been provided by the student at that time. Students who have not provided this documentation at the time of admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech. The student is responsible for requesting all required official documents and for any associated costs. The university reserves the right to deny degree conferral to any student who fails to provide the required certification of official documents.

Degree-seeking graduate 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, either provided by the student, or sent directly from the institution conferring the degree to the university's Office of Graduate Admission. Students that have not provided this documentation at the time of admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech.

Degree-seeking graduate students with an earned baccalaureate degree from a foreign institution of higher learning: verification of the baccalaureate degree will be satisfied by the submission and satisfactory review of the required original documents (or copies of original documents) and English translations, either sent directly from the institution(s) conferring the degree(s), provided by the student, or provided by an accepted international credential evaluation service to the university's Office of Graduate Admission. Students who have not provided this documentation at the time of admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech. 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.

Non-degree graduate students: verification of the baccalaureate degree is not required to pursue non-degree graduate courses, but must be provided in accordance with the above criteria should a student convert to degree-seeking status. Students who have not provided this documentation at the time of degree-seeking admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech.

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

Any applicant whose undergraduate degree was earned at an institution where the primary language of instruction is not English must submit Test of English as a Foreign Language (TOEFL), Pearson Test of English (PTE), International English Language Testing System (IELTS), or Duolingo English Test scores.

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.

By accepting admission to the university, the student is agreeing to take any additional English courses that Illinois Institute of Technology deems necessary. Academic departments always reserve the right to require an English language assessment from any applicant. The below policy does not apply to Stuart School of Business students, who should reference the Professional Communication Advancement section (p. 36) for the correct English assessment policy.

To be considered for admission without an English language requirement, the minimum total and section scores for each examination are listed in the table below.

Examination	Minimum Total Score	Minimum Section Score
Internet-Based TOEFL	90	20
Paper-Based TOEFL	600	55
PTE	63	53
IELTS	6.5	6.5

Students admitted with the scores below are required to take an English language assessment. Students will be assessed in any skill area according to the section score.

Examination	Minimum Total Score	Minimum Section Score
Internet-Based TOEFL	70-89	<20
Paper-Based TOEFL	550-599	<55
PTE	47-62	<53
IELTS	5.5-6.0	<6.5

Upon completion of the English language assessments, students will be given a placement report indicating the English language program course or courses they are required to take during their studies. If students score high on a test proving proficiency in that area, they can waive out of a course and will not need to take that course.

Graduate English Proficiency Policies and Procedures

- English language assessments are mandatory for newly admitted graduate students with low proficiency test scores. One to four corresponding exams may be administered. English language assessment(s) may also be required by the academic department decision-maker during the admission review.
- Waivers are applied based on the assessment score results and entered directly by English Language Services. Waivers are not requested by the adviser.
- After the English language scores are populated in the student's record, students are preregistered in a generic PESL 000 placeholder course for three credit hours using an automated process.
- After student-initiated academic course selection and registration period, the appropriate English language course section registration is administratively entered on the Friday before PESL courses begin; students may check the final registration schedule via the MyIIT portal (my.iit.edu).
- A student with multiple English language requirements may reassess (in the following semester) after the first English language course is successfully completed. There is a fee associated with the reassessment.
- English language course enrollment (three credit hours) applies toward the full-time enrollment requirements of nine credit hours per regular academic semester for immigration purposes.
- Students MUST make a reservation in order to take the English language assessment at english.iit.edu/assessments.
- Continuing students are automatically registered for each remaining PESL course requirement, one per semester, after the student's academic course registration is completed unless a waiver(s) has been applied from the assessment or reassessment results.

Assessment Placement and Waiver Scores

Level 0 PESL Course

Listening	N/A
Speaking	N/A
Reading	N/A
Writing	PESL-040

Level 1 PESL Course

Listening	PESL-021
Speaking	PESL-061
Reading	PESL-031
Writing	PESL-041

Level 2 PESL Course

Listening	PESL-022
Speaking	PESL-062
Reading	PESL-032
Writing	PESL-042

Waiver Auto Applied with ESL Score

Listening	110+
Speaking	63+
Reading	117+
Writing	7+

Financial Support

All qualified applicants are considered for all available and appropriate scholarships and assistantships at the time of their application review. Students awarded scholarships or assistantships are typically notified at the time of their admission. While all qualified applicants are considered for funding, awards are competitive and most scholarships or assistantships are awarded to a small number of selected students with outstanding credentials.

The I-20 or DS-2019 cannot be issued until an acceptable affidavit of financial support is received, along with requisite supporting bank, loan, or scholarship documents detailing the available funds. Funds must be liquid and available for immediate use in the United States to cover at least one academic year of tuition and estimated living expenses. Documents must be dated within six months of the student's beginning date. Simple statements from parents or relatives to pay all expenses are not acceptable. Applicants on F-1 student visas are not eligible for part-time employment during their first year of enrollment.

Completion of international applications after the published final deadlines may not allow time for a decision to be made and/or a visa to be issued for the semester requested. 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. Students must submit and complete a new online application, and provide all required materials, in order to be considered for second graduate degree.

Newly Admitted Students

Admitted students and international students who have already submitted a sufficient affidavit of financial support should submit an Intent to Enroll Form and pay the deposit online to indicate whether or not they plan to attend Illinois Tech. Housing information, initial registration instructions, a medical examination form, and immunization requirements are also available to admitted students. For international students, the admission packet will include the I-20 or DS-2019. To register in the semester for which they were admitted, students must return the completed medical form and immunization form, and contact their assigned academic adviser.

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
312.567.5075
housing@iit.edu
web.iit.edu/housing

Admission does not include commitments for room and board. A 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 first day of class each semester, the Office of Graduate Admission must be notified at grad.admission@iit.edu. Arriving late without prior notification may result in being dropped from the admitted program, or cancellation of a SEVIS ID.

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. Students committed to attending Illinois Tech should submit their tuition deposit through their student portal, which will be applied toward their first semester tuition statement.

All students who wish to defer their enrollment for up to one academic year must request the deferment by contacting the Office of Graduate Admission (grad.admission@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 meningitis, 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 online class per semester, and will not be on campus during the semester, 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: iit.edu/financial-aid

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

Mission Statement

The financial aid team strives to educate, empower, and support students with an understanding of financial aid options and resources in approachable environment.

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.

Student Eligibility Requirements to Receive Federal and State 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 for graduates, 6 credit hours or more per semester for undergraduates), and demonstrate academic progress towards graduation to qualify for federal and state aid. In some circumstances, undergraduates enrolled in fewer than six credit hours will be eligible for federal or state grants. Satisfactory Academic Progress (SAP) includes a minimum grade point average, a sufficient percentage of credit hours earned each semester, and timely progress 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 and state 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. Illinois Institute of Technology's Title IV School Code is **001691**. All federal financial assistance is awarded on an annual basis, hence a FAFSA must be filed each academic year. Students are encouraged to file a FAFSA at their earliest convenience because some state and campus-based awards are awarded on a first-come first-served basis. 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 income information to the Office of Financial Aid.

New students should not wait for a final admission decision before filing the FAFSA. Applicants are encouraged to complete a FAFSA at their earliest convenience in order to qualify for potential state and campus-based funds.

Determining Financial Need for Assistance

Financial need is the difference between a student's total cost of attendance (COA) at the university and the student's expected family contribution (EFC). The total COA at the university includes tuition, mandatory fees, room and board, books and supplies, transportation, loan fees, and personal expenses. 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 (if applicable) his/her family. One of the principles of need-based assistance is that students and their families are expected to help pay some of a student's educational expenses.

Federal Financial Aid Programs

Federal Work-Study Program

The Federal Work-Study (FWS) program provides campus-based job funding for students with demonstrated financial need. Students awarded FWS can earn money to help pay educational expenses. Eligible students 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 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 by the Office of Student Employment through the Handshake platform.

Direct Loan Programs

Illinois Institute of Technology participates in the Direct Loan program with the Department of Education. Fixed interest rates for the loans in this program are determined each year on July 1 by Congress. The funds for these loans come from the federal government. Below are the types of Direct Loan programs offered to students at the university.

Federal Direct Stafford Loans (Subsidized and Unsubsidized)

The Subsidized Stafford Loan is awarded to undergraduate students based on demonstrated financial need. Interest does not accrue while the student is enrolled at least half-time. The Unsubsidized Stafford Loan is a non-need based loan awarded to both undergraduate and graduate students. Interest accrues from the time the student receives the loan funds. Students have the option of paying the interest while enrolled or having the interest added to the principal upon graduation or after dropping to less than half-time enrollment. Both Stafford Loans are charged an origination fee each year before the loan disburses to the student.

Federal Direct PLUS Loans

PLUS Loans enable parents and graduate students with good standing credit to borrow money to help cover educational expenses. If a borrower is denied for this loan, they may reapply with an endorser. If a parent is not approved for the loan, the Office of Financial Aid may offer additional Unsubsidized Stafford Loan funds to an undergraduate. PLUS Loans cannot be taken in an undergraduate student's name.

Additional Information

All **federal** financial aid awards for graduate students (excluding law students) are processed by the Office of Financial Aid. The office operates from 9 a.m. – 5 p.m., Monday through Friday.

Applying for a Financial Assistantship

A fellowship provides financial support to defray the cost of tuition and/or 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 any awards with their admission decision or shortly thereafter. 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 after April 15 for the fall semester is considered a binding decision for some university departments. If a student's academic work is judged to be unsatisfactory, awards may be canceled at the discretion of the university at any time 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 total of tuition scholarships, FWS, and loan eligibility cannot exceed a student's cost of attendance for the academic year. Previously awarded loans may be adjusted after a tuition scholarship notification.

Veterans' Educational Benefits

The Illinois Institute of Technology proudly participates in administering the Montgomery GI Bill®, Post 9/11 GI Bill®, and the Yellow Ribbon® Program. Beneficiaries who plan to utilize VA benefits at the university can find all relevant information on the Office of Financial Aid's website. For the first semester using benefits, students must submit a copy of their Certificate of Eligibility and complete the Veteran Benefit Process Application. Any documentation or questions can be directed to the School Certifying Official (SCO) by emailing veterans@iit.edu or calling 312.567.7952. Beneficiaries should keep in mind that VA benefits can only be utilized for courses that are required for their academic program. Additionally, beneficiaries must maintain reasonable academic progress according to university standards. Failure to meet minimum-progress criteria can result in the loss of eligibility for educational benefits.

Taxation of Scholarships, Fellowships, and Stipends**U.S. Citizen or Resident Alien**

A scholarship/fellowship payment received by a candidate for 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, and/or 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, and/or 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.

Gainful Employment Information

As of July 1, 2011, institutions were required to 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. As of July 1, 2017, disclosures were made available online for each program on the individual program page.

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. Additionally, Illinois Institute of Technology's accreditor does not require the calculation of job placement rates and therefore the university was unable to disclose such rates.

As of July 2019, schools are no longer required to disclose these details starting in July 2020. Thus, the above information is for reference. Gainful Employment regulations may change after 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.

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 sponsorship. 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 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.

Graduate 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 admitted undergraduate student 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. This deposit will disburse on the first day of class and will appear on the billing statement for the semester.

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.

Undergraduate Tuition

Undergraduates registered for 12-24 credit hours are considered full-time and will be charged full-time tuition and fees. Undergraduates registered for fewer than 12 credit hours are considered part-time and will be charged the per-credit-hour, part-time tuition and fee rate.

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

Other Fees and 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. 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.

Book Advance

The Student Accounting Office has partnered with the Illinois Institute of Technology Barnes & Noble bookstore to allow students with a student account credit balance to purchase books and supplies at the bookstore. This partnership provides students with a convenient way to purchase books prior to the start of classes using anticipated Title IV credits, eliminating the wait for a refund check. Students purchase books at either the university bookstore location or Barnes and Noble online and the charge is applied to the student account directly. Students who opt-in to this option need to complete the Title IV authorization form (p. 23).

Parking Fee

All students parking in campus parking lots must register their vehicle 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 (see waiver). Students must submit their waiver each fall (or spring for spring start students). 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, or student.health@iit.edu, for further details.

E-Bills

Each semester, billing statements will be made available to students through the MyIIT portal (my.iit.edu) through the Manage My Account icon. Billing statements are also sent to other individuals or third parties that a student designates as an authorized user(s) and for whom the student has provided the university with an email address. This billing 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 payments.

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 clicking on the Manage My Account icon located in the menu bar. Students may view their charges, due dates for these charges, payments, and credits from financial aid at any time.

Payment of all charges for a term is due on the first day of the term to which the charges apply. If students pay less than the total amount due by the respective due date, they 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 their 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 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 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 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 their financial obligation to the university. A student will be considered delinquent when their 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 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 Authorization

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 who are employed by a company that offers tuition reimbursement an opportunity to defer the reimbursable portion of their tuition until three weeks 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 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 (Illinois Tech) 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 must 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 who 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 as penalty fees assessed to their accounts due to lack of payment.

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 Office of Residence 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 the Office of Residence 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 Computing, Institute of Design, Lewis College of Science and Letters, 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

Applied Mathematics (p. 297)
 Architecture (p. 267)
 Architectural Engineering (p. 111)
 Biology (p. 404)
 Biomedical Engineering (p. 59)
 Chemical Engineering (p. 73)
 Chemistry (p. 418)
 Civil Engineering (p. 112)
 Computer Engineering (p. 170)
 Computer Science (p. 325)
 Design (p. 387)
 Electrical Engineering (p. 172)
 Environmental Engineering (p. 112)
 Food Science and Nutrition (p. 431)
 Management Science (p. 527)
 Materials Science and Engineering (p. 228)
 Mechanical and Aerospace Engineering (p. 229)
 Molecular Biochemistry and Biophysics (p. 405)
 Physics (p. 460)
 Psychology (p. 464)
 Rehabilitation Counseling Education (p. 481)
 Technology and Humanities (p. 446)

Law Degrees

Doctor of the Science of Law (J.S.D.) (p. 234)
 Juris Doctor (J.D.) (p. 234)
 Master of Laws (LL.M.) (p. 234)
 J.D./LL.M. in Family Law (p. 234)
 J.D./LL.M. in Financial Services Law (joint degree) (p. 234)
 J.D./LL.M. in Taxation (joint degree) (p. 234)
 J.D./M.B.A. (joint degree) (p. 234)
 J.D./M.P.A. (joint degree) (p. 234)
 J.D./M.S. in Environmental Management and Sustainability (joint degree) (p. 234)
 J.D./M.S. in Finance (joint degree) (p. 234)
 J.D./Master of Public Health (joint degree in cooperation with University of Illinois at Chicago) (p. 234)

Master of Science Degrees

Analytical Chemistry (p. 415)
 Applied Cybersecurity and Digital Forensics (p. 361)
 Applied Mathematics (p. 289)
 Applied Physics (p. 458)
 Architectural Engineering (p. 107)
 Architecture (p. 266)
 Autonomous Systems and Robotics (p. 211)

Biology (p. 397)
 Biology for the Health Professions (p. 398)
 Biomedical Data Science and Modeling (p. 56)
 Biomedical Engineering (p. 57)
 Chemical Engineering (p. 72)
 Chemistry (p. 416)
 Civil Engineering (p. 109)
 Computational Decision Sciences and Operations Research (p. 295)
 Computer Engineering (p. 158)
 Computer Engineering/Electrical Engineering (dual degree) (p. 161)
 Computer Science (p. 323)
 Electrical Engineering (p. 167)
 Environmental Engineering (p. 111)
 Environmental Management and Sustainability (p. 524)
 Finance (p. 525)
 Food Process Engineering (p. 429)
 Food Safety and Technology (p. 430)
 Industrial-Organizational Psychology (p. 473)
 Information Technology and Management (p. 363)
 Management Science (p. 526)
 Manufacturing Engineering (p. 213)
 Marketing Analytics (p. 527)
 Materials Science and Engineering (p. 216)
 Mechanical and Aerospace Engineering (p. 217)
 Medical Devices and Biomaterials (p. 58)
 Molecular Biochemistry and Biophysics (p. 403)
 Physics (p. 459)
 Psychology (p. 474)
 Rehabilitation and Mental Health Counseling (p. 475)
 Technical Communication and Information Architecture (p. 444)
 Technology and Humanities (p. 445)

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 may be 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.

Advanced Manufacturing (M.E.) (p. 42)
 Applied Mathematics (p. 284)
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 Architecture/Landscape Architecture (dual degree) (p. 260)
 Architectural Engineering (M.E.) (p. 97)
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 Artificial Intelligence for Computer Vision and Control (M.E.)
 Biological Engineering (p. 69)
 Biomedical Engineering (M.E.) (p. 56)
 Biomedical Imaging and Signals (p. 140)
 Business Administration (M.B.A.) (p. 517)
 Business Administration/Design (dual degree) (p. 384)
 Business Administration/M.S. in Environmental Management and Sustainability (dual degree) (p. 486)
 Business Administration/M.S. in Finance (dual degree) (p. 486)
 Business Administration/M.S. in Marketing Analytics (dual degree) (p. 486)
 Business Administration/Public Administration (dual degree) (p. 486)
 Chemical Engineering (p. 69)
 Computational Engineering (p. 42)
 Computer Engineering in Internet of Things
 Computer Science (p. 313)
 Construction Engineering and Management (M.E.) (p. 99)
 Cyber Forensics and Security (p. 353)
 Cyber Security Engineering (p. 144)
 Cybersecurity (p. 318)
 Data Science (p. 285)
 Design (p. 381)
 Design Methods (p. 384)
 Design/Public Administration (dual degree) (p. 386)
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 Electricity Markets (p. 146)

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 Food Safety and Technology (p. 428)
 Geotechnical Engineering (M.E.) (p. 101)
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 Information Technology and Management (p. 354)
 Intellectual Property Management and Markets (p. 554)
 Landscape Architecture (p. 256)
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 Materials Science and Engineering (M.E.) (p. 209)
 Mathematical Finance (p. 287)
 Mechanical and Aerospace Engineering (M.E.) (p. 210)
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 Pharmaceutical Engineering (p. 71)
 Power Engineering (p. 149)
 Public Administration (M.P.A.) (p. 522)
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 Technological Entrepreneurship (p. 524)
 Telecommunications and Software Engineering (p. 150)
 Transportation Engineering (M.E.) (p. 102)
 Urban Systems Engineering (M.E.) (p. 42)
 VLSI and Microelectronics (p. 152)
 Wireless Communications and Computer Networks

Accelerated Master's Program (AMP)

There are four paths to the completion of an accelerated master's degree at Illinois Tech:

1. Co-terminal paired bachelor's and master's programs completed concurrently (see more information in the Co-Terminal Degree Programs section (p. 27))
 - a. These programs have been pre-selected for pairing between the same academic discipline of undergraduate study or a different discipline.
 - b. Graduate co-terminal admission is required when a student reaches a minimum of 60 earned or in-progress credit hours (see more information in the Synopsis of Co-Terminal Studies section (p. 35)).
 - c. The student must submit a declaration of shared and non-shared courses (explicitly for graduate use) in the first semester of co-terminal enrollment.
2. Co-terminal unpaired bachelor's and master's programs completed concurrently
 - a. These programs are not a pre-selected pair.
 - b. The student must have advance approval from both the undergraduate and graduate academic units for the program of interest, including the intended shared courses.
 - i. The approval process is called a Declaration of Intent (p. 35) and may be filed after the first semester of undergraduate enrollment.
 - ii. Selected shared courses must explicitly satisfy the approved graduate curriculum without course substitution.
 - c. Subsequent admission to the master's program of interest is required.
 - d. The student must submit a declaration of shared and non-shared courses (explicitly for graduate use) in the first semester of co-terminal enrollment.
3. Post-baccalaureate master's program (Illinois Tech alums only)
 - a. A master's program that has explicit course requirements, of which the student has fulfilled some shared courses during the completion of an Illinois Tech bachelor's degree.
 - b. The bachelors will be earned no earlier than three years prior to the first term of master's enrollment.
 - i. Up to nine credit hours of relevant coursework may be shared between the two degrees.
 - ii. Consideration of course substitution is at the discretion of the graduate academic unit.
4. Dual degree program with an Illinois Tech partner institution
 - a. Two concurrent master's degree programs, with prior agreement for specific programs between Illinois Tech and a selected partner institution.
 - b. The number of applicable shared credits is determined by the terms of the partnership agreement, but may not exceed nine credit hours. In most cases six credit hours are allowed.
 - c. Consideration of course substitution is at the discretion of the graduate academic unit.

Co-Terminal Degree Programs

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 nine credit hours), students may complete both a bachelor's and master's degree in as few as five years. Up to a combined total of nine applicable credit hours earned prior to matriculation into an Illinois Institute of Technology graduate degree program, subject to the graduate studies rules and restrictions, may be considered for 1) external transfer credit for graduate transfer credit use; 2) internal transfer credit from an Illinois Institute of Technology undergraduate program; and/or 3) shared co-terminal program credit. More information regarding this policy is available in the Transfer Credit section (p. 560) of the Graduate Bulletin.

All co-terminal 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.

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

The following are legacy co-terminal degree pairings as of June 2020. Students may also work with advisers to identify alternate bachelor's and master's degree pairings, pending the approval of the prospective graduate program and the student's undergraduate program. More information is available in the Co-Terminal Advising section (p. 557) of this bulletin.

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 Applied Mathematics/Master of Mathematical Finance

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 for the Health Professions
 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 Biology/Master of Science in Biology for the Health Professions
 Bachelor of Science in Biomedical Engineering/Master of Science in Biology for the Health Professions
 Bachelor of Science in Chemistry/Master of Science in Biology for the Health Professions
 Bachelor of Science in Molecular Biochemistry and Biophysics/Master of Science in Molecular Biochemistry and Biophysics

Business

Bachelor of Science in Applied Mathematics/Master of Mathematical Finance
 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 Chemistry/Master of Science in Environmental Management and Sustainability
 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

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 Science in Computer Engineering
 Bachelor of Science in Computer Engineering/Master of Science in Electrical 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 Materials Science and Engineering/Master of
Engineering in Materials Science and 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.

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 Particle Processing (p. 79)
 Pharmaceutical Engineering (p. 80)
 Polymer Science and Engineering (p. 80)
 Process Operations Management (p. 80)

Chemistry

Analytical Method Development (p. 419)
 Analytical Spectroscopy (p. 419)
 Chromatography (p. 419)
 Materials Chemistry (p. 420)
 Regulatory Science (p. 420)

Civil, Architectural, and Environmental Engineering

Air Resources (p. 118)
 Architectural Engineering (p. 118)
 Construction Management (p. 118)
 Earthquake and Wind Engineering Design (p. 119)
 Hazardous Waste Management (p. 119)
 Indoor Air Quality (p. 120)
 Infrastructure Engineering and Management (p. 119)
 Transportation Systems Planning (p. 121)
 Water and Wastewater Treatment (p. 121)

Computer Science

Computational Intelligence (p. 328)
 Cyber-Physical Systems (p. 328)
 Data Analytics (p. 328)
 Database Systems (p. 329)
 Distributed and Cloud Computing (p. 329)
 Information Security and Assurance (p. 330)
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Electrical and Computer Engineering

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Food Science and Nutrition

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Humanities

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Information Technology and Management

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 Data Center Operations and Management (p. 367)
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 Information Technology Innovation, Leadership, and Entrepreneurship (p. 368)
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Mechanical, Materials, and Aerospace Engineering

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Physics

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 Rehabilitation Counseling (p. 482)
 Rehabilitation Engineering Technology (p. 482)

Professional Certificates

Stuart School of Business

Business Administration

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Public Administration

Economic Development and Social Entrepreneurship (p. 531)
Nonprofit and Mission-Driven Management (p. 533)
Public Management (p. 533)
Security, Safety, and Risk Management (p. 534)

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 by traditional graduate students 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 by traditional graduate students with a minimum of 32 credit hours earned beyond the bachelor's degree.

Two additional master's completion options are applicable to qualified students: 1) graduate transfer credit of up to nine credit hours; or 2) accelerated master's admission after bachelor's degree completion at Illinois Tech.

With academic approval, a maximum of nine credit hours, earned prior to matriculation into an Illinois Tech graduate program, may be applied to a master's degree, subject to the graduate studies rules and restrictions published in the Transfer Credit section (p. 560) of the Graduate Bulletin. In special cases, students may obtain course credit by completing a Credit by Proficiency Examination (p. 559), subject to the approval of their respective advisers, academic unit heads, and the Dean of the Graduate College.

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. Required Graduate Advising Meeting	A required graduate advising meeting must be completed by a masters student, within nine credit hours of earned and/or enrolled coursework.
5. Final thesis/comprehensive examination for M.S. or MAS where applicable	Department submits Form G303 (if required). ¹
6. Final M.S. thesis committee appointed and preliminary thesis title approved	Form G301B (if required).
7. Thesis fee (if applicable)	Student Accounting Touchnet Paid Online receipt.
8. M.S. thesis approval signed by the thesis examiner	Form G501.
9. Completion of courses and other requirements	Listed in the Graduate Bulletin and the Graduate Degree Works Worksheet Final Audit, including approved exceptions.
10. Fulfillment of all financial obligations to the university	
11. 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.
12. 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 .
13. 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	
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. Required Graduate Advising Meeting	A required graduate advising meeting must be completed by a doctoral student, within 18 credit hours of earned and/or enrolled coursework.
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. Final Ph.D. thesis committee appointed and preliminary thesis title approved	Form G301B.
10. Final thesis defense/oral examination	Department submits exam results on Form G309. ¹
11. Thesis fee	Student Accounting Touchnet Paid Online receipt.
12. Ph.D. thesis approval signed by the thesis examiner	Form G501.
13. Completion of courses and other requirements	Listed in the Graduate Bulletin and the Graduate Degree Works Worksheet Final Audit, including approved exceptions.
14. Fulfillment of all financial obligations to the university	
15. 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.
16. 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 .
17. 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 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 nine credit hours), students may complete both a bachelor's and master's degree in as few as five years. Up to a combined total of nine applicable credit hours earned prior to matriculation into an Illinois Institute of Technology graduate degree program, subject to the graduate studies rules and restrictions, may be considered for 1) external transfer credit for graduate transfer credit use; 2) internal transfer credit from an Illinois Institute of Technology undergraduate program; and/or 3) shared co-terminal program credit. More information regarding this policy is available in the Transfer Credit section (p. 560) of the Graduate Bulletin.

All co-terminal 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.

Declaration of Intent

Students who wish to enroll in a co-terminal program should file a Declaration of Intent as early as their first semester of enrollment at the university. This declaration signals an intent to apply to a co-terminal program in the student's junior year, should academic criteria be met. This declaration is especially critical for students who wish to pursue a customized co-terminal degree pairing and will help identify any deficiencies or prerequisite courses for the prospective graduate degree program. The Office of Undergraduate Academic Affairs will monitor the student's declaration until such time as the student may apply to be fully admitted to a co-terminal master's degree in their junior year, subject to the admission policies of the graduate academic unit.

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:

- August 1 for fall semester
- December 1 for spring semester
- May 1 for summer semester (all sessions)

Questions regarding co-terminal admission should be addressed to the Office of Graduate Admission at grad.admission@iit.edu.

Co-Terminal Shared and Non-Shared Credit Form

Before completion of nine credit hours of graduate coursework applicable to the co-terminal degree program, and in the first semester of co-terminal enrollment, a Co-Terminal Shared and Non-Shared Credit Form must be filed with and approved by the co-terminal academic adviser, the academic unit head, and the Office of Graduate Academic Affairs. The Co-Terminal Shared and Non-Shared Credit Form is created and filed in eForms for Degree Works, which is accessed through a tab in Graduate Degree Works. Graduate Degree Works is located the MyIIT portal (my.iit.edu) under the Academics tab in the Graduate Academic Affairs channel. The Co-Terminal Shared and Non-Shared Credit Form 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.

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, they 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 Accelerated Master's Program (p. 27) admission consideration in the future.

English Language Services

The mission of English Language Services at Illinois Institute of Technology is to provide engaging English language instruction in a dynamic learning environment relevant to the academic and professional needs of non-native learners.

English Language Services offers several options for students to develop their language abilities. To view more information about the English Language Services department and what they offer, please visit english.iit.edu. English Language Services is accredited by CEA (the Commission on English Language Program Accreditation), and under the university through the Higher Learning Commission (HLC), and is licensed to operate under the Illinois Board of Higher Education.

To view information about specific programs and courses, please visit the Language Courses section (p. 36) of this bulletin. Programs include:

- Intensive English and Pathway Program
- English Language Program (commonly referred to as PESL)
- Professional Communication Advancement
- English for Design

English Language Services also offers special programs/courses for visiting groups as well as individuals who want to study part-time. Contact us at els@iit.edu to find out more.

Supplemental English Language Courses

English language courses are not for academic credit and may be required as a condition of admission. English Language Services offers the following programs:

- English Language Program (ELP) (p. 36)
- Professional Communication Advancement (PCA) (p. 37)
- English for Design (EFD) (p. 37)
- Intensive English Program (IEP) (p. 37)

English Language Program

English Language Program courses, commonly referred to as PESL, are supplemental English language courses for undergraduate and graduate students. They provide a linguistic bridge for currently admitted international students who need improvement with the English language. Illinois Institute of Technology offers skill-building courses in academic reading, listening, writing, and oral communication that develop linguistic as well as cultural competence. Courses in the English language program, when all of the skill-building courses are taken concurrently, also serve as additional semesters for English-only students continuing from the Intensive English Program. English language courses for graduate and undergraduate students begin with PESL 0##. Undergraduate course sections begin with U. English language courses beginning with ELP 8## are taken by students opting into supplemental English language courses that are not part of a degree program.

More information about English competency requirements is available in the Undergraduate Admission section and Graduate Admission section (p. 11) of the university bulletins. Frequently Asked Questions (FAQs) about the English competency requirements are available on the English Language Services website (appliedtech.iit.edu/english-language-services/faqs-assessments).

PESL 021	Listening Enhancement I	3
PESL 022	Listening Enhancement II	3
PESL 031	Reading and Vocabulary Development I	3
PESL 032	Reading and Vocabulary Development II	3
PESL 040	Fundamentals of Academic Writing	3
PESL 041	Academic Writing I	3
PESL 042	Academic Writing II	3
PESL 061	Effective Communication I	3
PESL 062	Effective Communication II	3
ELP 821	Listening Enhancement I	3.5

ELP 822	Listening Enhancement II	3.5
ELP 831	Reading and Vocabulary Development I	3.5
ELP 832	Reading and Vocabulary Development II	3.5
ELP 840	Fundamentals of Academic Writing	3.5
ELP 841	Academic Writing I	3.5
ELP 842	Academic Writing II	3.5
ELP 861	Effective Communication I	3.5
ELP 862	Effective Communication II	3.5
ELP 899	Special Topics in English as a Second Language	9

Professional Communication Advancement

Stuart School of Business partners with English Language Services to provide the Professional Communication Advancement (PCA) program for international students to receive a customized and targeted approach to communications skill-building. PCA is designed to help students achieve success during their time at Stuart and as they move into the job market and the global business environment. PCA offers a variety of half-semester courses, each targeting specific English-language or communications competencies. Students will take part in customized language advancement studies that meet their personal needs.

Learn more about the English competency requirements for Stuart School of Business graduate students in the Stuart School of Business section (p. 485) of the Graduate Bulletin. Frequently Asked Questions (FAQs) about the Stuart School of Business English competency requirements are available on the English Language Services website (appliedtech.iit.edu/english-language-services/pca-faqs-assessments).

PCA 510	Communication Essentials	1.5
PCA 515	Strategies for Effective Communication	1.5
PCA 520	Advanced Communication Skills	1.5
PCA 525	Advanced Presentation Skills	1.5
PCA 530	Writing for Academic and Professional Success I	1.5
PCA 540	Writing for Academic and Professional Success II	1.5
PCA 550	Writing for the U. S. Workplace	1.5
PCA 570	Advanced Strategies for Clear Communication	1.5

English for Design

Institute of Design partners with English Language Services to offer a unique program of study that combines English for Specific Purpose instruction with graduate-level design education. The program is taught over two semesters concurrently with coursework in the Master of Design. Its goal is to help students from outside of the United States perfect their English fluency inside, and outside, of the classroom. In English + Design, students broaden their design vocabulary and increase their understanding of design in the U.S. Students in the English + Design program complete 18 additional credit hours of instruction while pursuing their design courses. This adds approximately one semester total to the standard Master of Design program.

Learn more about the English competency requirements for the Institute of Design in the Institute of Design section (p. 373) of the Graduate Bulletin.

IDN 461	Advanced Reading and Writing for Design I	3
IDN 462	Advanced Listening and Presentation in Design I	3
IDN 463	Cross-Cultural Communication I	2
IDN 464	Cross-Cultural Communication I Laboratory	1
IDN 466	Advanced Reading and Writing in Design II	3
IDN 467	Advanced Listening and Presentation in Design II	3
IDN 468	Culture and Communication in Design II	2
IDN 469	Cross-Cultural Communication II Laboratory	1

Intensive English Program

The Intensive English Program (IEP) at Illinois Institute of Technology is designed to meet the personal, professional, and academic goals of international students. The program consists of the following:

- Four levels of instruction, from high-beginning to advanced
- Core skills: Listening/Speaking, Reading/Writing, Grammar
- Elective courses: American Culture, Pronunciation, and Test Prep

- 18 total hours of class per week = 18 credit hour equivalents (no credit toward degrees)
- Classes meet daily Monday to Friday between 9 a.m. and 5 p.m. [Click here to view example schedule.](#)
- 15 students average in a class

Students accepted to the IEP will study English, meet new people from different countries and cultures, and will experience Chicago while preparing for their academic and professional careers. Experienced full-time and part-time instructors with graduate degrees assist students in achieving their language goals.

Please visit english.iit.edu/iep for more information.

IEP 021	IEP Listening and Speaking Level I	8.5
IEP 022	IEP Listening and Speaking Level II	6
IEP 023	IEP Listening and Speaking Level III	6
IEP 024	IEP Listening and Speaking Level IV	6
IEP 025	IEP Listening and Speaking	1-10
IEP 026	Pronunciation	3
IEP 028	Advanced Pronunciation	3
IEP 041	IEP Reading and Writing Level I	6
IEP 042	IEP Reading and Writing Level II	6
IEP 043	IEP Reading and Writing Level III	6
IEP 044	IEP Reading and Writing Level IV	6
IEP 045	IEP Reading and Writing	1-10
IEP 061	IEP Grammar Level I	3
IEP 062	IEP Grammar Level II	3
IEP 063	IEP Grammar Level III	3
IEP 064	IEP Grammar Level IV	3
IEP 065	IEP Grammar	4.3
IEP 071	Introduction to United States Culture	3
IEP 073	United States Culture	3
IEP 075	TOEFL Preparation for IEP	3
IEP 077	GRE Preparation for IEP	3
IEP 081	English for Special Purposes	1.9-4.9
IEP 082	English for Special Purposes: Architecture	1.9-4.9
IEP 083	English for Special Purposes: Engineering	1.9-4.9
IEP 096	Independent Study and Special Projects	21

COLLEGES

Armour College of Engineering (p. 42)

Kenneth T. Christensen
Dean
Perlstein Hall, Suite 224
10 W. 33rd St.
Chicago, IL 60616
312.567.3009
iit.edu/engineering

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, almost 2,200 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 Higher Learning Commission (HLC).

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.

Chicago-Kent College of Law (p. 232)

Anita K. Krug
Dean
565 W. Adams St.
Chicago, IL 60661
312.906.5000
kentlaw.iit.edu

Chicago-Kent College of Law is the second-oldest law school in Illinois. When it joined the university in 1969, Illinois Institute of Technology became the first major institute of technology to include law among its disciplines.

Chicago-Kent offers programs leading to the degrees of Juris Doctor, Master of Laws, and Doctor of the Science of Law, and participates in joint-degree programs with Stuart School of Business and the University of Illinois-Chicago.

College of Architecture (p. 239)

Reed Kroloff
Dean
S.R. Crown Hall
3360 S. State St.
Chicago, IL 60616
312.567.3230
arch.iit.edu

The program in architecture was established at Armour Institute of Technology, one of Illinois Institute of Technology's predecessors, in 1895. In 1938, the program came under the directorship of the world-renowned architect and educator Ludwig Mies van der Rohe. The college is housed in S. R. Crown Hall, a National Historic Landmark, one of Mies' most significant buildings, and a major contribution to Chicago's rich architectural heritage. The college emphasizes applied studio work under the instruction of practicing architects; the study of architectural theory; interdisciplinary learning; digital technologies; sustainability; design/build; and international study.

College of Computing (p. 272)

Lance Fortnow
Dean
IIT Tower, Suite 1400

10 W. 35th Street
 Chicago, IL 60616
 312.567.5922
iit.edu/computing

The College of Computing, founded in 2020, is the newest college at Illinois Tech dedicated to ensuring students across campus have the computing and data science ideas and skills needed to succeed in today's technological society. The college offers dozens of degrees and certificates in computing from the foundational to the applied as well as mathematical and manufacturing processes through our four departments/programs: Applied Mathematics, Computer Science, Industrial Technology and Management and Information Technology and Management."

Institute of Design (p. 372)

Denis Weil
 Dean
 3137 S. Federal St.
 Chicago, IL 60616
 312.595.4900
id.iit.edu

Since its founding as the New Bauhaus in 1937, the Institute of Design has grown into the largest full-time graduate-only design program in the U.S. with students from around the world. The school offers a professional Master of Design degree program with areas of study in communication design, interaction design, product design, strategic design, systems thinking, and user research; a dual Master of Design/ M.B.A. degree program in partnership with the Stuart School of Business; the Master of Design Methods, a nine-month program for mid-career professionals; and a Ph.D. in Design. The Institute of Design created the country's first Ph.D. design program in 1991.

Lewis College of Science and Letters (p. 389)

Christine L. Himes
 Interim Dean
 Robert A. Pritzker Science Center, Room 252
 3105 S. Dearborn St.
 Chicago, IL 60616
 312.567.3956
iit.edu/science-letters

The Lewis College of Science and Letters traces its roots to the Lewis Institute, founded in 1895, and to Armour Institute of Technology, founded in 1892. 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, research, data analysis, and communications. The college offers rigorous and relevant programs in the sciences and humanities at the undergraduate and graduate level (including master's, professional master's, and Ph.D.) through seven departments: biology; chemistry; food science and nutrition; humanities; physics; psychology; and social sciences.

Stuart School of Business (p. 483)

John F. O. Bilson
 Dean
 IIT Tower, 18th Floor
 10 W 35th Street
 Chicago, IL 60616
 312.906.6500
iit.edu/stuart

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, incisiveness, leadership, and sustainability are interwoven throughout coursework and professional development opportunities, offering students thorough preparation for the challenges of the next economy.

Stuart was established in 1969 with a gift from Illinois Institute of Technology alumnus and noted financier Harold Leonard Stuart. The school houses the Entrepreneurship Academy, the Center for Financial Innovation, and the Center for Strategic Competitiveness.

Stuart offers the following degrees: B.S. in Business Administration, co-terminal B.S.B.A. and M.P.A, co-terminal B.S.B.A. and M.S. in Finance, co-terminal B.S.B.A. and M.S. in Marketing Analytics, Master of Business Administration (M.B.A.), Master of Mathematical Finance (M.M.F.) offered in partnership with the College of Science Department of Applied Mathematics, M.S. in Environmental Management and Sustainability, M.S. in Finance, M.S. in Management Science, M.S. in Marketing Analytics, Master of Public Administration (M.P.A.), Master of

Technological Entrepreneurship, and Ph.D. in Management Science. A series of dual degrees with Chicago-Kent College of Law and Institute of Design are also offered, as well as numerous graduate certificate programs.

Armour College of Engineering

Kenneth T. Christensen
Dean
Perlstein Hall, Suite 224
10 W. 33rd St.
Chicago, IL 60616
312.567.3009
iit.edu/engineering

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Armour College of Engineering Interdisciplinary Programs

- Master of Computational Engineering
 - Biomedicine Track (p. 55) (Department of Biomedical Engineering)
 - Computational Chemical Engineering Track (p. 70) (Department of Chemical and Biological Engineering)
 - Computational Mechanics Track (p. 203) (Department of Mechanical, Materials, and Aerospace Engineering)
 - Optimization, Machine Vision, and Decision Making Track (p. 141) (Department of Electrical and Computer Engineering)
- Master of Engineering Management
 - Product Design and Development Track (p. 204) (Department of Mechanical, Materials, and Aerospace Engineering)
 - Project Management Track (p. 104) (Department of Civil, Architectural, and Environmental Engineering)
- Master of Pharmaceutical Engineering (p. 71) (Department of Chemical and Biological Engineering)
- Master of Engineering in Advanced Manufacturing
 - Additive Manufacturing Track (p. 205) (Department of Mechanical, Materials, and Aerospace Engineering)
 - Automation and Control Systems Track (p. 153) (Department of Electrical and Computer Engineering)
 - Digital Manufacturing Track (p. 205) (Department of Mechanical, Materials, and Aerospace Engineering)
- Master of Engineering in Energy Systems
 - Energy Conservation and Buildings Track (p. 99) (Department of Civil, Architectural, and Environmental Engineering)
 - Energy Generation and Sustainability Track (p. 206) (Department of Mechanical, Materials, and Aerospace Engineering)
 - Energy Transmission and Markets Track (p. 156) (Department of Electrical and Computer Engineering)
- Master of Engineering in Urban Systems Engineering
 - Monitoring and Control of Urban Systems Track (p. 103) (Department of Civil, Architectural, and Environmental Engineering)
 - Urban Building Systems Track (p. 103) (Department of Civil, Architectural, and Environmental Engineering)
 - Urban Transportation Systems Track (p. 104) (Department of Civil, Architectural, and Environmental Engineering)

Biomedical Engineering (p. 46)

- Master of Engineering in Biomedical Engineering (p. 56)
- Master of Science in Biomedical Data Science and Modeling (p. 56)
- Master of Science in Biomedical Engineering (p. 57)
- Master of Science in Medical Devices and Biomaterials (p. 58)
- Doctor of Philosophy in Biomedical Engineering (p. 59)

Chemical and Biological Engineering (p. 60)

- Master of Biological Engineering (p. 69)
- Master of Chemical Engineering (p. 69)
- Master of Science in Chemical Engineering (p. 72)
- Doctor of Philosophy in Chemical Engineering (p. 73)

Interdisciplinary Programs

- Master of Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 74)
- Master of Science in Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 75)
- Doctor of Philosophy of Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 77)

Certificate Programs

- Biological Engineering (p. 79)
- Current Energy Issues (p. 79)
- Particle Processing (p. 79)
- Pharmaceutical Engineering (p. 80)
- Polymer Science and Engineering (p. 80)
- Process Operation Management (p. 80)

Civil, Architectural, and Environmental Engineering (p. 82)

- Master of Engineering in Architectural Engineering (p. 97)
- Master of Engineering in Construction Engineering and Management (p. 99)
- Master of Engineering in Environmental Engineering (p. 101)
- Master of Engineering in Geotechnical Engineering (p. 101)
- Master of Engineering in Structural Engineering (p. 101)
- Master of Engineering in Transportation Engineering (p. 102)
- Master of Public Works (p. 105)
- Master of Science in Architectural Engineering (p. 107)
- Master of Science in Civil Engineering with specialization in: (p. 109)

Construction Engineering and Management
Geotechnical Engineering
Structural Engineering
Transportation Engineering

- Master of Science in Environmental Engineering (p. 111)
- Doctor of Philosophy in Civil Engineering (p. 112)
- Doctor of Philosophy in Environmental Engineering (p. 112)

Interdisciplinary Programs

- Master of Engineering in Environmental Engineering with Specialization in Energy/Environment/Economics (E3) (p. 113)
- Master of Science in Environmental Engineering with Specialization in Energy/Environment/Economics (E3) (p. 114)
- Doctor of Philosophy in Environmental Engineering with Specialization in Energy/Environment/Economics (E3) (p. 116)

Certificate Program in Architectural Engineering

- Architectural Engineering (p. 118)

Certificate Programs in Civil Engineering

- Construction Management (p. 118)
- Earthquake and Wind Engineering Design (p. 119)
- Infrastructure Engineering and Management (p. 119)
- Transportation Systems Planning (p. 121)

Certificate Programs in Environmental Engineering

- Air Resources (p. 118)
- Hazardous Waste Engineering (p. 119)

- Indoor Air Quality (p. 120)
- Water and Wastewater Treatment (p. 121)

Electrical and Computer Engineering (p. 122)

- Master of Biomedical Imaging and Signals (p. 140)
- Master of Computer Engineering in Internet of Things
- Master of Cyber Security Engineering (p. 144)
- Master of Electrical and Computer Engineering (p. 145)
- Master of Engineering in Artificial Intelligence for Computer Vision and Control
- Master of Engineering in Wireless Communications and Computer Networks
- Master of Network Engineering (p. 147)
- Master of Power Engineering (p. 149)
- Master of VLSI and Microelectronics (p. 152)
- Master of Science in Computer Engineering (p. 158)
- Master of Science in Electrical Engineering (p. 167)
- Doctor of Philosophy in Computer Engineering (p. 170)
- Doctor of Philosophy in Electrical Engineering (p. 172)

Dual Degree Program

- Master of Science in Computer Engineering and Electrical Engineering (p. 161)

Joint Degree Programs

- Master of Telecommunications and Software Engineering (with Computer Science) (p. 150)
- Master of Electricity Markets (with Finance) (p. 146)

Interdisciplinary Programs

- Master of Electrical and Computer Engineering with Specialization in Energy/Environment/Economics (E3) (p. 172)
- Master of Science in Electrical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 174)
- Doctor of Philosophy in Electrical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 179)

Certificate Programs

- Advanced Electronics (p. 181)
- Applied Electromagnetics (p. 181)
- Communication Systems (p. 182)
- Computer Engineering (p. 182)
- Control Systems (p. 183)
- Electricity Markets (p. 184)
- Power Electronics (p. 184)
- Power Engineering (p. 185)
- Signal Processing (p. 186)
- Wireless Communications Engineering (p. 186)

Mechanical, Materials, and Aerospace Engineering (p. 188)

- Master of Engineering in Manufacturing Engineering (p. 208)
- Master of Engineering in Materials Science and Engineering (p. 209)
- Master of Engineering in Mechanical and Aerospace Engineering (p. 210)
- Master of Science in Autonomous Robotic Systems (p. 217)
- Master of Science in Manufacturing Engineering (p. 213)
- Master of Science in Materials Science and Engineering (p. 216)
- Master of Science in Mechanical and Aerospace Engineering (p. 217)
- Doctor of Philosophy in Materials Science and Engineering (p. 228)
- Doctor of Philosophy in Mechanical and Aerospace Engineering (p. 229)

Interdisciplinary Programs

- Master of Engineering in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3) (p. 218)
- Master of Engineering in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (p. 220)
- Master of Science in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3) (p. 222)
- Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (p. 224)

Certificate Programs

- Computer Integrated Design and Manufacturing (p. 231)
- Product Quality and Reliability Assurance (p. 231)

Biomedical Engineering

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Chicago, IL 60616
312.567.5324
bme@iit.edu
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 three faculty members hold tenure track positions 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

Research Areas

- Cell and tissue engineering
- Medical imaging
- Neural engineering

Admission Requirements

Minimum Cumulative Undergraduate GPA

3.2/4.0

Minimum GRE 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 Computational Engineering, Biomedicine Track (p. 55)
- Master of Engineering in Biomedical Engineering (p. 56)
- Master of Science in Biomedical Data Science and Modeling (p. 56)
- Master of Science in Biomedical Engineering (p. 57)
- Master of Science in Medical Devices and Biomaterials (p. 58)
- Doctor of Philosophy in Biomedical Engineering (p. 59)

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 BME

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 502

Introduction to Regulatory Science for Engineers

Engineers must be equipped to answer the growing demands for new medical technologies. Introduction to Regulatory Science teaches engineers how the regulated environment impacts the design, testing, and delivery of medical devices. It will equip students with the essential skills and tools critical to the practice of engineering in the medical device industry. In this course, students will be exposed to the core concepts, processes, and tools surrounding the global medical device regulatory framework, and will gain foundational knowledge for the practical application of regulations throughout the product development lifecycle. From knowledge gained in the class, students will be expected to work in teams and use critical thinking, data analysis and interpretation skills to research, evaluate, and present a scientific, technical, and legally justifiable approach for the global introduction of a new medical device.

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 with min. grade of C

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 will be described. Instructor permission required.

Prerequisite(s): BME 505 with min. grade of C and BME 503 with min. grade of C

Lecture: 2 Lab: 0 Credits: 2

BME 509

Vertebrate Neural Systems

This lab-centered course teaches students the fundamental principles of mammalian 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 and MATH 252 and BME 335

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 and Tissue 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**Introduction to Medical Devices, BioMEMS and Microfluidics**

This course will present fundamentals and applications of medical devices, BioMEMS, and microfluidic technologies for applications in the broad health and biomedical engineering. It will provide a broad view of the general field and a knowledge of relevant fabrication methods and analysis techniques. Fabrication and analytical techniques, interfacing with biological materials, and techniques for analyte detection will be emphasized. The course will include individual projects and critical paper reviews in which each student will be encouraged to master basic concepts in design and fabrication for devices for specific applications.

Lecture: 3 Lab: 0 Credits: 3

BME 526**Advanced Biomedical Engineering Design**

This course aims to educate students on project definition, and on the design, development, and technology transfer of potential biomedical products in the context of the student's major capstone project. Students will learn best practices for designing a marketable medical device, including the design process from the clinical problem definition through prototype and clinical testing to market readiness. Permission from instructor is required.

Lecture: 3 Lab: 0 Credits: 3

BME 527**Extracellular Matrix Biology**

This course is the same as the BME 427 Extracellular Matrix Biology course that has been approved for banner listing for Summer 2020. BME527 is the same class to extend this course to graduate students. The Extra Cellular Matrix (ECM) is that which connects cells in tissues and provides much of the organization and support in almost every tissue and organ system of the body. Thus the aim of this course is to give students insights into ECM biology and its relevance to modern medicine and biomedical (tissue) engineering. A significant portion of working population is suffering from ECM-related maladies, and the focus of research has shifted into creating ECM implants. The ECM implant market is growing rapidly. For instance, the collagen meniscus implant market was reported to be at \$308.6 million in 2018. Understanding the implications of the molecular biology of ECM to feed into this research is highly relevant for students considering careers (academic and industry) in life sciences in industry, academia and healthcare. Extracellular Matrix (ECM) is a highly complex system in mammalian biology responsible for structural support and functional (biochemical) signals for physiology. Specific amino acid sequences on the various ECM elements are responsible to trigger intra- and extracellular cascades leading to cell division, proliferation, tissue regeneration, wound healing and inflammation. This course will focus on the following key concepts: a) Gene expression, structure and function of various ECM proteins and complexes and the physiological processes. b) Etiology and the molecular progression of diseases caused by abnormalities to ECM proteins. c) Mechanobiology of various ECM proteins. d) Structure function and mechanical function of ECM interfaces with other tissues (muscle, bone, skin etc.) e) Implications for tissue engineering and development of novel biomimetic and biological ECM implants.

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 532 with min. grade of C and BME 530 with min. grade of C

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 545**Quantitative Neural Function**

Computational approach to basic neural modeling and function, including cable theory, ion channels, presynaptic potentials, stimulation thresholds, and nerve blocking techniques. Synaptic function is examined at the fundamental level.

Prerequisite(s): BME 453 with min. grade of C or BME 553* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

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 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. Students will implement physiological models using Matlab.

Prerequisite(s): BIOL 453 or BIOL 430

Lecture: 3 Lab: 0 Credits: 3

BME 560**Methods in Biomedical Data Science**

The course provides an overview of predictive and descriptive statistical modeling methods for large biomedical datasets. Building on undergraduate-level knowledge of statistics, the course introduces Bayes and information theory, develops from these modeling algorithms and provides a series of biomedical application areas. Methods include meta-analytic techniques, linear and non-linear dimensionality reduction, traditional "non-deep" predictive tools (e.g. perceptron, support vector machines, logistic regression, decision trees, boosting, etc.), and some applications of deep neural networks. Application areas may include medical imaging (e.g. image segmentation), EEG and ECG signal analysis (e.g. anomaly detection), genetics (e.g. imputation methods, polygenic risk score computation, cell-free DNA analysis, etc.). Each course module involves analysis of real data using existing modeling libraries and students' own implementation. The predictive results may be compared to the state-of-the-art for each example dataset to assess the usefulness of the models. (3-0-3)

Prerequisite(s): MATH 225

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 addressed.

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 with min. grade of C

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: 3 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

ENGR 502**Medical Device Regulations and Commercialization**

This course helps prepare students for commercializing medical devices within a highly-regulated environment. Concepts include protecting intellectual property, the structure and scope of the Federal Drug Administration (FDA), developing, testing, producing and marketing medical devices under FDA regulations, total product lifecycle, and quality management.

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

ENGR 510**Strategic Engineering Management**

This course will review technology-based enterprises and the driving forces that impact corporate strategy. Students will learn how to apply engineering knowledge to determine technology/product direction and make/buy/partnering decisions. Relationships between research and development, operations, finance, marketing, and other functions within engineering-based organizations that drive strategic decisions will be examined. Strategy development and competitive analysis will be included. Case studies from the industry relevant to the student's engineering track will be reviewed.

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

ENGR 520**Best Practices in Engineering Project Management**

Many engineering projects suffer due to weak business cases, schedule slippages, and cost overruns. This course presents commonly used tools and techniques and best practices to build an effective business case, develop a realistic schedule and budget, and successfully execute and complete a project. Students are introduced to a generic project management life cycle model, review basic project management principles, tools, and techniques, and learn engineering-tailored best practices used by high performing, project-centric organizations. Students have an opportunity to apply selected tools in the form of short classroom exercises.

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

ENGR 521**Risk Management in Engineering Projects**

In project management, a risk is considered an uncertain event that may have a positive or a negative impact on project objectives. Managing identified threats individually through customized strategies is key to project success. Similarly, opportunities must be leveraged for better project outcomes. Implementation of an effective risk management process is imperative for today's complex projects. This course presents a five-step process to manage project threats as well as opportunities. On every project, students will be able to identify and analyze risks and develop response strategies for each identified risk and take proper response action to manage the risks. Industry best practices and quantitative tools and simulations are used to analyze risk.

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

ENGR 531**Urban Systems Engineering Design**

ENGR 531 is a project-based course where students will explore integrated designs of urban systems. Each project will apply the students' engineering disciplines (such as structures, transportation, building science, construction engineering and management, environmental engineering) in a comprehensive analysis that considers the economic, human, and environmental issues associated with the project.

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

ENGR 532**Urban Systems Engineering Seminar**

ENGR 532 is an active seminar course that emphasizes current topics in urban systems engineering. Invited speakers will include researchers and representatives from current practice, such as municipal and regional planners and consultants. Appropriate readings will be assigned in advance of each speaker to guide students in preparation for active discussion with each speaker. Each student will also write a term paper on an urban systems engineering topic of their choice, connecting material from the assigned reading, the speakers, and additional references selected by the student.

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

ENGR 534**Product Design and Innovation**

This course covers all aspects of planning new products or services that are commercially viable and add to a company's suite of offerings. It includes such topics as user research, market analysis, need/problem identification, creative thinking, ideation, conceptual, competitive benchmarking, human factors, prototyping, evaluation, and testing. The course includes creative, analytical, and technical skills in a balanced approach using such teaching methods as case studies, individual exercises, and group projects.

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

ENGR 539**Robotic Motion Planning**

Configuration space. Path planning techniques including potential field functions, roadmaps, cell decomposition, and sampling-based algorithms. Kalman filtering. Probabilistic localization techniques using Bayesian methods. Trajectory planning.

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

ENGR 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

ENGR 573**Construction Contract Administration**

Characteristics of the construction industry. Project delivery systems. Duties and liabilities of the parties at the pre-contract stage. Bidding. Contract administration including duties and liabilities of the parties regarding payments, retainage, substantial and final completion, scheduling and time extensions, change orders, changed conditions, suspension of work, contract termination, and resolution of disputes. Contract bonds. Managing the construction company. Labor law and labor relations.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 575**Systems Analysis in 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

ENGR 576**Nano Manufacturing**

This course covers the general methods used for micro- and nano-fabrication and assembly, including photolithography techniques, physical and chemical deposition methods, masking, etching, and bulk micromachining as well as self-assembly techniques. It also covers nanotubes, nanowires, nanoparticles, and the devices that use them, including both electronic and mechanical-electronic systems, as well as nano-structural materials and composites. Focus is on commercially available current processes as well as emerging technologies and evolving research areas. Sensing and instrumentation as well as nano-positioning and actuation are covered briefly.

Lecture: 3 Lab: 0 Credits: 3

ENGR 587**Introduction to Digital Manufacturing**

This course is about the digital revolution taking place in the world of manufacturing and how students, workers, managers, and business owners can benefit from the sweeping technological changes taking place. It is about the change from paper-based processes to digital-based processes all through the design/manufacturing/deliver enterprise, and across the global supply chain. It touches on digital design, digital manufacturing engineering, digital production, digital quality assurance, and digital contracting, from large companies to small. There is also a significant focus on cyber security and the new types of threats that manufacturers face in the new digital world. Other topics covered include intelligent machines, connectivity, the digital thread, big data, and the Industrial Internet of Things (IIoT).

Lecture: 3 Lab: 0 Credits: 3

ENGR 588**Additive Manufacturing**

This course examines the fundamentals of a variety of additive manufacturing processes as well as design for additive manufacturing, materials available, and properties and limitations of materials and designs. It also examines the economics of additive manufacturing as compared to traditional subtractive manufacturing and other traditional techniques. Additive techniques discussed include 3D printing, selective laser sintering, stereo lithography, multi-jet modeling, laminated object manufacturing, and others. Advantages and limitations of all current additive technologies are examined as well as criteria for process selection. Processes for metals, polymers, and ceramics are covered. Other topics include software tools and connections between design and production, direct tooling, and direct manufacturing. Current research trends are discussed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 592**Engineering Management Capstone Experience**

Students apply the knowledge they have acquired in the Engineering Management program to a specific problem or case study. Projects will be identified and mentored in conjunction with faculty and industrial partners. A final report or business plan is required that reflects the focus of the capstone project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 595**Product Development for Entrepreneurs**

Elements of product development (mechanical and electrical), manufacturing and production planning, supply chain, marketing, product research, and entrepreneurship concepts are taught in this class. In this course, student teams will be required to create a compelling product that has potential to be sold in today's marketplace. They will be required to create functional prototypes of their product for people to use and critique. If successful, students will be allowed to put their product on Kickstarter.com and take orders for delivery after the class is complete while potentially fostering their own business as a result of this course.

Lecture: 3 Lab: 0 Credits: 3

ENGR 596**Practical Engineering Training**

This course is a mentored, immersive practical engineering training. Students learn under the direction of professional engineers and practicing engineers by working on real engineering projects. The student will perform hands-on engineering, including learning and developing/applying engineering principles and concepts to complete the project assigned to the student. The student will apply engineering ethics and safety during their practical engineering training. Students will communicate the results of their work in written and oral communications. Students will receive assignments of varying complexity consistent with their graduate standing.

Lecture: 0 Lab: 9 Credits: 3

ENGR 598**Graduate Research Immersion: Team Project**

This course provides a faculty-mentored immersive team-based research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

ENGR 599**Graduate Research Immersion: Individual**

This course provides a faculty-mentored immersive research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

Master of Computational Engineering, Biomedicine Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
Select nine credit hours from the following courses:		9
BME 522	Math Methods in BME	3
BME 553	Quantitative Physiology	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 536	Computational Techniques Engg	3
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
MMAE 532	Finite Element Methods II	3
Biomedicine Courses		(12)
Select 12 credit hours from the following courses:		12
BME 445	Quantitative Neural Function	3
BME 523	Cell Biomechanics	3
BME 524	Quant Aspects Cell/Tissue Engg	3
BME 525	Introduction to Medical Device	3
BME 538	Neuroimaging	3
BME 597	Special Problems	1-6
CHE 516	Tech for Treatment of Diabetes	3
or BME 517	Tech for Treatment of Diabetes	
CHE 585	Drug Delivery	3
ECE 565	Compt Vision Image Processing	3
Elective Courses		(9)
Select nine credit hours from the following courses: ¹		9
BME 445	Quantitative Neural Function	3
BME 522	Math Methods in BME	3
BME 523	Cell Biomechanics	3
BME 524	Quant Aspects Cell/Tissue Engg	3
BME 525	Introduction to Medical Device	3
BME 538	Neuroimaging	3
BME 553	Quantitative Physiology	3
BME 597	Special Problems	1-6
CAE 530	Finite Element Method of Anlys	3
CAE 534	Computational Techniques	3
CAE 535	Nonlinear Finite Element Anlys	3
CAE 597	Special Problems	1-9
CHE 439	Numerical Data Analysis	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 516/BME 517	Tech for Treatment of Diabetes	3
CHE 535	Applctn Math Cheml Engrg	3
CHE 536	Computational Techniques Engg	3
CHE 560	Ststcl Qlty Process Control	3
CHE 585	Drug Delivery	3
CHE 597	Special Problems	1-9

ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 563	Comptl Intllgnc Engineering	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 597	Special Problems	1-9
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 450	Computational Mechanics II	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 518	Spec Methods Comp Fluid Dynmcs	3
MMAE 532	Finite Element Methods II	3
MMAE 570	Computational Methods in MSE	3
MMAE 597	Special Topics	1-9

Total Credit Hours

30

¹ Course must not have been used towards the core course or specialization course requirements.

Master of Engineering in Biomedical Engineering

The overall objective of the Master of Engineering in 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

Code	Title	Credit Hours
BME 500	Intro to Biomedical Engrg	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 Data Science and Modeling

The overall objective of the Master of Science in Biomedical Data Science and Modeling is to provide education and training relevant to professional employment in computational biomedical engineering. Special emphasis is placed on principles of mathematical modeling, machine learning, biostatistics, and bioinformatics. 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 coursework that demonstrates proficiency in math and computer science.

Curriculum

Requirement	Credits
Requirement	
Minimum Credits Required	32
Maximum 400-Level Credit	9
Minimum 500-Level Credit	23
Maximum Transfer Credit	9

Code	Title	Credit Hours
Required Courses		(20-21)
BME 500	Intro to Biomedical Engrg (In Fall 2020, we will change credit hours of BME 500 from 3 to 2)	2-3
BME 533 or BME 433	Biostatistics BME Applications of Statistics	3
BME 553	Quantitative Physiology	3
BME 560	Methods in Biomedical Data Sci	3
BME 522 or BME 422	Math Methods in BME Math Methods for Biomedel Engrs	3
BIOL 550	Bioinformatics	3
ECE 566	Machine and Deep Learning	3
Elective Courses		(12)
Select 2 courses from the following list (6 credits) plus an additional 6 credits of Math/Life Science/Eng courses recommended from this list. Other courses may be selected with adviser approval prior to course registration.		12
CS 577	Deep Learning (or)	3
CS 579	Online Social Network Analysis (or)	3
MATH 522	Mathematical Modeling (or)	3
MATH 569	Statistical Learning (or)	3
MATH 571	Data Preparation and Analysis (or)	3
MATH 577	Computational Mathematics I (or)	3
Total Credit Hours		32-33

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; six to eight 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

Requirement	Credits
Minimum Degree Credits	32
Maximum 400-Level Credit	9

Code	Title	Credit Hours
Required Courses		(12)
BME 500	Intro to Biomedical Engrg	3
BME 522	Math Methods in BME	3
BME 533	Biostatistics	3
BME 553	Quantitative Physiology	3
Elective Courses		(12)
Select six credit hours of 400- or 500-level life science and/or advanced mathematics and/or engineering courses with adviser approval		6
Select six credit hours of 400- or 500-level BME courses with adviser approval		6
Thesis Research		(6-8)
BME 591	Research & Thesis MS Degree	6-8

Master of Science in Medical Devices and Biomaterials

The overall objective of the Master of Medical Device and Biomaterials is to provide education and training relevant to the design and development of medical devices. Special emphasis is placed on principles of engineering design methodology, computational and modeling aspects of medical devices, and design and use of biomaterials in medical devices. Students will be encouraged to apply for internship and co-op opportunities. 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 coursework that demonstrates proficiency in math.

The admission requirements for the degree include a relevant undergraduate degree with the following **minimum requirements**: an earned GPA of 3.0, GRE composite score of 300 and quantitative score of 80%, 2 semesters of Calculus and 1 semester of Differential Equations.

Curriculum

Requirement	Credits
Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 500-Level Credit	20
Maximum Transfer Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(20-21)
BME 500	Intro to Biomedical Engrg	2-3
BME 525	Introduction to Medical Device	3
BME 526	Advanced Design	3
BME 533	Biostatistics	3
BME 553	Quantitative Physiology	3
CHE 580	Biomaterials	3
IDX 542	Analysis + Synthesis in Design	3
Elective Courses		(12)
Select 2 courses from the following list (6 credits) plus an additional 6 credits of Math/Life Science/Eng courses recommended from this list. Other courses may be selected with adviser approval prior to course registration.		12
BME 523	Cell Biomechanics ((or))	3
BME 524	Quant Aspects Cell/Tissue Engg ((or))	3
BIOL 514	Toxicology ((or))	3
BME 594	Special Projects ¹	3-6
CHE 506	Entrepreneurship & IP Mgmt ((or))	3
CHE 585	Drug Delivery ((or))	3
MMAE 451	Finite Elmnt Methods in Engrg	3
Total Credit Hours		32-33

¹ An independent research project may be completed to fulfill credit hour requirements.

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.

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

Center of Excellence in Polymer Science and Engineering
Fouad Teymour, 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 Arastoopour, 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 Battery Lab
Fuel Cell Lab
Fluidization Lab
Gas Processing Lab
Hydrogen Storage 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

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

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

- Master's: 295 (quantitative + verbal), 2.5 (analytical writing)
- Master of Science: 304 (quantitative + verbal), 3.0 (analytical writing)
- Ph.D.: 304 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

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 2.5/4.0. 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.

Degree Programs

- Master of Biological Engineering (p. 69)
- Master of Chemical Engineering (p. 69)
- Master of Computational Engineering, Computational Chemical Engineering Track (p. 70)
- Master of Pharmaceutical Engineering (p. 71)
- Master of Science in Chemical Engineering (p. 72)
- Doctor of Philosophy in Chemical Engineering (p. 73)

Interdisciplinary Programs

- Master of Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 74)
- Master of Science in Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 75)
- Doctor of Philosophy of Chemical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 77)

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.

- Biological Engineering (p. 79)
- Current Energy Issues (p. 79)
- Particle Processing (p. 79)
- Pharmaceutical Engineering (p. 80)
- Polymer Science and Engineering (p. 80)
- Process Operations Management (p. 80)

Course Descriptions

CHE 501

Transport Phenomena

The equations of change (mass, momentum, and energy transport) for single phase and single component, multiphase and multicomponent systems. Analytical and numerical solution to equations of change for Velocity, Temperature and Concentration distribution with more than one independent variable in chemical and biological processes. Dimensional analysis for problem reduction.

Prerequisite(s): CHE 302 and CHE 301

Lecture: 3 Lab: 0 Credits: 3

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 with min. grade of C and CHE 451 with min. grade of C

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 514

Process Analytical Technology

Process Analytical Technology (PAT) is introduced as a framework to enhance process understanding and assist in the development of reliable and efficient pharmaceutical operations. The course covers the definition of critical performance attributes within the context of FDA regulations; an overview of analytic measurement methods of chemical, physical and biological quantities; statistical data analysis and chemometric methods, including statistical process monitoring, multivariate analysis and parameter estimation; and design of real-time decision systems, including automatic control operations and risk-based analysis of final product quality. Prerequisite: BS in engineering or equivalent.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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.

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 with min. grade of C and CHE 451 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or CHE 451 with min. grade of C) and CHE 406 with min. grade of C

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:** 1 **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:** 1 **Credits:** 1

CHE 691**Research and Thesis for Ph.D. Degree**

Credit: Variable

ENGR 502**Medical Device Regulations and Commercialization**

This course helps prepare students for commercializing medical devices within a highly-regulated environment. Concepts include protecting intellectual property, the structure and scope of the Federal Drug Administration (FDA), developing, testing, producing and marketing medical devices under FDA regulations, total product lifecycle, and quality management.

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

ENGR 510**Strategic Engineering Management**

This course will review technology-based enterprises and the driving forces that impact corporate strategy. Students will learn how to apply engineering knowledge to determine technology/product direction and make/buy/partnering decisions. Relationships between research and development, operations, finance, marketing, and other functions within engineering-based organizations that drive strategic decisions will be examined. Strategy development and competitive analysis will be included. Case studies from the industry relevant to the student's engineering track will be reviewed.

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

ENGR 520**Best Practices in Engineering Project Management**

Many engineering projects suffer due to weak business cases, schedule slippages, and cost overruns. This course presents commonly used tools and techniques and best practices to build an effective business case, develop a realistic schedule and budget, and successfully execute and complete a project. Students are introduced to a generic project management life cycle model, review basic project management principles, tools, and techniques, and learn engineering-tailored best practices used by high performing, project-centric organizations. Students have an opportunity to apply selected tools in the form of short classroom exercises.

Lecture: 3 Lab: 0 Credits: 3

ENGR 521**Risk Management in Engineering Projects**

In project management, a risk is considered an uncertain event that may have a positive or a negative impact on project objectives. Managing identified threats individually through customized strategies is key to project success. Similarly, opportunities must be leveraged for better project outcomes. Implementation of an effective risk management process is imperative for today's complex projects. This course presents a five-step process to manage project threats as well as opportunities. On every project, students will be able to identify and analyze risks and develop response strategies for each identified risk and take proper response action to manage the risks. Industry best practices and quantitative tools and simulations are used to analyze risk.

Lecture: 3 Lab: 0 Credits: 3

ENGR 531**Urban Systems Engineering Design**

ENGR 531 is a project-based course where students will explore integrated designs of urban systems. Each project will apply the students' engineering disciplines (such as structures, transportation, building science, construction engineering and management, environmental engineering) in a comprehensive analysis that considers the economic, human, and environmental issues associated with the project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 532**Urban Systems Engineering Seminar**

ENGR 532 is an active seminar course that emphasizes current topics in urban systems engineering. Invited speakers will include researchers and representatives from current practice, such as municipal and regional planners and consultants. Appropriate readings will be assigned in advance of each speaker to guide students in preparation for active discussion with each speaker. Each student will also write a term paper on an urban systems engineering topic of their choice, connecting material from the assigned reading, the speakers, and additional references selected by the student.

Lecture: 3 Lab: 0 Credits: 3

ENGR 534**Product Design and Innovation**

This course covers all aspects of planning new products or services that are commercially viable and add to a company's suite of offerings. It includes such topics as user research, market analysis, need/problem identification, creative thinking, ideation, concepting, competitive benchmarking, human factors, prototyping, evaluation, and testing. The course includes creative, analytical, and technical skills in a balanced approach using such teaching methods as case studies, individual exercises, and group projects.

Lecture: 3 Lab: 0 Credits: 3

ENGR 539**Robotic Motion Planning**

Configuration space. Path planning techniques including potential field functions, roadmaps, cell decomposition, and sampling-based algorithms. Kalman filtering. Probabilistic localization techniques using Bayesian methods. Trajectory planning.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 573**Construction Contract Administration**

Characteristics of the construction industry. Project delivery systems. Duties and liabilities of the parties at the pre-contract stage. Bidding. Contract administration including duties and liabilities of the parties regarding payments, retainage, substantial and final completion, scheduling and time extensions, change orders, changed conditions, suspension of work, contract termination, and resolution of disputes. Contract bonds. Managing the construction company. Labor law and labor relations.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 575**Systems Analysis in 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

ENGR 576**Nano Manufacturing**

This course covers the general methods used for micro- and nano-fabrication and assembly, including photolithography techniques, physical and chemical deposition methods, masking, etching, and bulk micromachining as well as self-assembly techniques. It also covers nanotubes, nanowires, nanoparticles, and the devices that use them, including both electronic and mechanical-electronic systems, as well as nano-structural materials and composites. Focus is on commercially available current processes as well as emerging technologies and evolving research areas. Sensing and instrumentation as well as nano-positioning and actuation are covered briefly.

Lecture: 3 Lab: 0 Credits: 3

ENGR 587**Introduction to Digital Manufacturing**

This course is about the digital revolution taking place in the world of manufacturing and how students, workers, managers, and business owners can benefit from the sweeping technological changes taking place. It is about the change from paper-based processes to digital-based processes all through the design/manufacturing/deliver enterprise, and across the global supply chain. It touches on digital design, digital manufacturing engineering, digital production, digital quality assurance, and digital contracting, from large companies to small. There is also a significant focus on cyber security and the new types of threats that manufacturers face in the new digital world. Other topics covered include intelligent machines, connectivity, the digital thread, big data, and the Industrial Internet of Things (IIoT).

Lecture: 3 Lab: 0 Credits: 3

ENGR 588**Additive Manufacturing**

This course examines the fundamentals of a variety of additive manufacturing processes as well as design for additive manufacturing, materials available, and properties and limitations of materials and designs. It also examines the economics of additive manufacturing as compared to traditional subtractive manufacturing and other traditional techniques. Additive techniques discussed include 3D printing, selective laser sintering, stereo lithography, multi-jet modeling, laminated object manufacturing, and others. Advantages and limitations of all current additive technologies are examined as well as criteria for process selection. Processes for metals, polymers, and ceramics are covered. Other topics include software tools and connections between design and production, direct tooling, and direct manufacturing. Current research trends are discussed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 592**Engineering Management Capstone Experience**

Students apply the knowledge they have acquired in the Engineering Management program to a specific problem or case study. Projects will be identified and mentored in conjunction with faculty and industrial partners. A final report or business plan is required that reflects the focus of the capstone project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 595**Product Development for Entrepreneurs**

Elements of product development (mechanical and electrical), manufacturing and production planning, supply chain, marketing, product research, and entrepreneurship concepts are taught in this class. In this course, student teams will be required to create a compelling product that has potential to be sold in today's marketplace. They will be required to create functional prototypes of their product for people to use and critique. If successful, students will be allowed to put their product on Kickstarter.com and take orders for delivery after the class is complete while potentially fostering their own business as a result of this course.

Lecture: 3 Lab: 0 Credits: 3

ENGR 596**Practical Engineering Training**

This course is a mentored, immersive practical engineering training. Students learn under the direction of professional engineers and practicing engineers by working on real engineering projects. The student will perform hands-on engineering, including learning and developing/applying engineering principles and concepts to complete the project assigned to the student. The student will apply engineering ethics and safety during their practical engineering training. Students will communicate the results of their work in written and oral communications. Students will receive assignments of varying complexity consistent with their graduate standing.

Lecture: 0 Lab: 9 Credits: 3

ENGR 598**Graduate Research Immersion: Team Project**

This course provides a faculty-mentored immersive team-based research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

ENGR 599**Graduate Research Immersion: Individual**

This course provides a faculty-mentored immersive research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

Master of Biological Engineering

The objectives of this degree program are 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. Candidates are required to take a total of 30 credit hours: nine credit hours of core courses, six credit hours of required biology courses, three credit hours of a required professional course, and 12 credit hours of electives.

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
CHE 406	Transport Phenomena	3
CHE 503	Thermodynamics	3
CHE 577	Bioprocess Engineering	3
Biology Requirements		(6)
BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
Professional Requirement		(3)
CHE 506	Entrepreneurship & IP Mgmt	3
Electives		(12)
Select 12 credit hours from the following:		12
BME 525	Introduction to Medical Device	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 Engrng	1
CHE 597	Special Problems	1-20
ENVE 513	Biotech Processes in ENVE	3
Select any 500-level Food Process Engineering course		3
Other approved electives from CHE, CHEM, BME, BIOL		
Total Credit Hours		30

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, three 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

Code	Title	Credit Hours
Core Courses		(12)
CHE 406	Transport Phenomena	3
CHE 503	Thermodynamics	3
CHE 525	Chemical Reaction Engineering ¹	3
CHE 530	Advanced Process Control	3
or CHE 535	Applctn Math Cheml Engrg	
Professional Requirement		(3)
CHE 506	Entrepreneurship & IP Mgmt	3
Elective Courses		(15)

Select 15 credit hours	15
Total Credit Hours	30

¹ Note: Interested students can substitute CHE 577 for CHE 525 with adviser consent.

Master of Computational Engineering, Computational Chemical Engineering Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
Select nine credit hours from the following courses:		9
BME 522	Math Methods in BME	3
BME 553	Quantitative Physiology	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 536	Computational Techniques Engg	3
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Computational Chemical Engineering Courses		(12)
Select 12 credit hours from the following courses:		12
CHE 439	Numerical Data Analysis	3
CHE 535	Applctn Math Cheml Engrg	3
CHE 536	Computational Techniques Engg	3
CHE 597	Special Problems	1-12
Elective Courses		(9)
Select nine credit hours from the following courses: ¹		9
BME 445	Quantitative Neural Function	3
BME 522	Math Methods in BME	3
BME 523	Cell Biomechanics	3
BME 524	Quant Aspects Cell/Tissue Engg	3
BME 525	Introduction to Medical Device	3
BME 538	Neuroimaging	3
BME 553	Quantitative Physiology	3
BME 597	Special Problems	1-6
CAE 530	Finite Element Method of Anlys	3
CAE 534	Computational Techniques	3
CAE 535	Nonlinear Finite Element Anlys	3
CAE 597	Special Problems	1-9
CHE 439	Numerical Data Analysis	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 516/BME 517	Tech for Treatment of Diabetes	3
CHE 535	Applctn Math Cheml Engrg	3
CHE 536	Computational Techniques Engg	3
CHE 560	Ststcl Qlty Process Control	3
CHE 585	Drug Delivery	3
CHE 597	Special Problems	1-9
ECE 505	Applied Optimization Engrgs	3

ECE 511	Analysis Random Signals	3
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 563	Comptl Intlgn Engineering	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 597	Special Problems	1-9
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 450	Computational Mechanics II	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 518	Spec Methods Comp Fluid Dynmcs	3
MMAE 532	Finite Element Methods II	3
MMAE 570	Computational Methods in MSE	3
MMAE 597	Special Topics	1-9
Total Credit Hours		30

¹ Course must not have been used towards the core course or specialization course requirements.

Master of Pharmaceutical Engineering Curriculum

Code	Title	Credit Hours
Core Courses		(12)
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 577	Bioprocess Engineering	3
CHE 583	Pharmaceutical Engineering	3
CHE 585	Drug Delivery	3
Elective Courses		(18)
Select 18 credit hours from the following courses:		18
BIOL 515	Molecular Biology	3
BME 516	Biotechnology for Engineers	3
BME 525	Introduction to Medical Device	3
CHE 426	Statistical Tools Engineers	3
CHE 508	Process Dsgn Optimization	3
CHE 545	Metabolic Engineering	3
CHE 551	Advanced Tnsport Phenomena	3
CHE 560	Ststcl Qlty Process Control	3
CHE 580	Biomaterials	3
CHE 582	Intfcl Clldl Phmna Applctn	3
CHE 593	Seminar in Chemical Engrng (may be taken twice)	1
CHE 594	Special Projects	3-6
MMAE 556	Nano Manufacturing	3
MMAE 561	Solidification & Crystal Grwth	3
Total Credit Hours		30

Master of Science in Chemical Engineering

The objective of the Master of Science in Chemical Engineering program is to enable students to build a strong foundation in multiple areas of chemical engineering. The program requires 32 credit hours.

Students have the option of completing a thesis based on between six to eight credit hours of research (CHE 591) with the approval of a thesis adviser, completing a master's project with up to six credit hours of project coursework (CHE 594), or completing the program with coursework. In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with their adviser, in formulating a program.

Before the completion of the first semester of graduate study, full-time students should select a permanent adviser. Graduate students pursuing the degree on a part-time basis should select a permanent adviser before registering for their tenth credit hour. The student, in consultation with the adviser, prepares a program of study that reflects individual needs and interests. Students with the thesis option are required to pass an oral comprehensive examination on their thesis and related topics. The examination committee consists of at least three appropriate faculty members who are nominated by the thesis adviser and approved by the department chair.

Curriculum

Master of Science in Chemical Engineering (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12

Code	Title	Credit Hours
Core Courses		(12)
CHE 406	Transport Phenomena	3
CHE 503	Thermodynamics	3
CHE 525	Chemical Reaction Engineering ¹	3
CHE 530	Advanced Process Control	3
or CHE 535	Applctn Math Cheml Engrg	
Professional Course		(3)
CHE 506	Entrepreneurship & IP Mgmt	3
Elective Courses		(17)
Select 17 credit hours of 400-500 level CHE courses ²		17
Total Credit Hours		32

¹ Note: Interested students can substitute CHE 577 for CHE 525 with adviser consent.

² Other appropriate electives 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. 61) of this bulletin.

Master of Science in Chemical Engineering (Master's Project Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12

Code	Title	Credit Hours
Core Courses		(12)
CHE 406	Transport Phenomena	3
CHE 503	Thermodynamics	3
CHE 525	Chemical Reaction Engineering ¹	3
CHE 530	Advanced Process Control	3
or CHE 535	Applctn Math Cheml Engrg	
Professional Course		(3)
CHE 506	Entrepreneurship & IP Mgmt	3
Project Course		(1-6)
CHE 594	Special Projects	1-6

Elective Courses (11-16)

Select 11-16 credit hours of 400-500 level CHE courses ² 11-16

¹ Note: Interested students can substitute CHE 577 for CHE 525 with adviser consent.

² Other appropriate electives 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. 61) of this bulletin.

Master of Science in Chemical Engineering (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12

Code	Title	Credit Hours
Core Courses		(12)
CHE 525	Chemical Reaction Engineering ¹	3
CHE 535	Applctn Math Cheml Engrg ¹	3
CHE 551	Advanced Tnsport Phenomena ¹	3
CHE 553	Advanced Thermodynamics ¹	3
Thesis Research		(6-8)
CHE 591	Research and Thesis M.S.	6-8
Elective Courses		(12-14)
Select 12-14 credit hours of 400-500 level CHE courses ²		12-14

¹ A minimum grade point average of 3.0/4.0 is required for core courses in the thesis option only.

² Other appropriate electives 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. 61) of this bulletin.

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

Code	Title	Credit Hours
Core Courses		(15) ¹
CHE 525	Chemical Reaction Engineering ¹	3
CHE 530	Advanced Process Control ¹	3
or CHE 536	Computational Techniques Engg	
CHE 535	Applctn Math Cheml Engrg ¹	3
CHE 551	Advanced Tnsport 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 Ph.D.	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 section (p. 560) 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 six to eight credit hours of M.S. thesis research, students are required to register for two to five 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	Applctn Math Cheml Engrg	3
CHE 551	Advanced Tnsport Phenomena	3
CHE 553	Advanced Thermodynamics	3
Special Projects Research		(2-5)
CHE 594	Special Projects	2-5
E3 Courses		(9)
CHE 543	Energy Envir 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 five to eight credit hours		5-8
Recommended		(1)
CHE 593	Seminar in Chemical Engrng (or general seminars offered 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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 six to eight 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	Applctn Math Cheml Engrg ¹	3
CHE 551	Advanced Tnsport Phenomena ¹	3
CHE 553	Advanced Thermodynamics ¹	3
E3 Courses		(9)
CHE 543	Energy Envir 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 M.S.	6-8
Electives		(2-4)
Select two to four credit hours		2-4
Recommended		(1)
CHE 593	Seminar in Chemical Engrng (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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 Engg	
CHE 535	Applctn Math Cheml Engrg	3
CHE 551	Advanced Tnsport Phenomena	3
CHE 553	Advanced Thermodynamics	3
CHE 543	Energy Envir Economics	3
Select five 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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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.

Gainful Employment Disclosure for the Certificate in Biological Engineering

Curriculum

Code	Title	Credit Hours
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. 69)		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.

Gainful Employment Disclosure for Certificate in Current Energy Issues

Curriculum

Code	Title	Credit Hours
Required Courses		(9)
Select a minimum of three courses from the following:		9
CHE 541	Renwble Enrgy Technologies	3
CHE 542	Fludzatr Gas-Solids Flw System	3
CHE 543	Energy Envir Economics	3
CHE 565	Fund 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.

Gainful Employment Disclosure for Certificate in Particle Processing

Curriculum

A minimum of three courses (nine credit hours) is required for this certificate.

Code	Title	Credit Hours
Select a minimum of one course from the following:		3
CHE 489	Fluidization	3
CHE 542	Fludzatr Gas-Solids Flw System	3
Select one/two courses from the following:		3-6
CHE 551	Advanced Tnsport Phenomena	3
CHE 582	Intfcl Clldl Phnmna Applctn	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.

Gainful Employment Disclosure for Certificate in Pharmaceutical Engineering

Curriculum

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

Code	Title	Credit Hours
Required Courses		(12)
CHE 545	Metabolic Engineering	3
CHE 560	Ststcl Qlty 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.

Gainful Employment Disclosure for Certificate in Polymer Science and Engineering

Curriculum

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

Code	Title	Credit Hours
Required Courses		(12)
CHE 470	Intro Polymer Science	3
Select a minimum of three courses from the following:		9
CHE 538	Polymerization Reaction Engrg	3
CHE 555	Polymer Processing	3
CHEM 535	Polymer Synthesis	3
CHEM 542	Polymer Charact & 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.

Gainful Employment Disclosure for Certificate in Process Operations Management

Curriculum

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

Code	Title	Credit Hours
Required Courses		(12)
Select at least one of the following groups:		12
I		
CHE 426	Statistical Tools Engineers	3
CHE 560	Ststcl Qlty Process Control	3
II		
CHE 435	Process Control	3
CHE 508	Process Dsgn Optimization	3

CHE 530	Advanced Process Control	3	
Total Credit Hours			12

Civil, Architectural, and Environmental Engineering

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Chair

Brent Stephens

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. Faculty experience and an active research program provide relevant perspectives on current engineering challenges and issues.

Research Facilities

Research facilities include laboratories devoted to concrete structures, structural models, metal structures, materials, building energy and environmental systems, air quality monitoring, 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 resources and water resources 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, security and emergency management, transportation asset management, 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

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

- Master's/Master of Science: 292 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 292 (quantitative + verbal), 2.5 (analytical writing)

Minimum TOEFL Scores

80/213 (internet-based/paper-based test scores)

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 degree should contact the department for counseling before registering for courses.

Degree Programs

- Master of Engineering Management, Project Management Track (p. 104)
- Master of Engineering in Architectural Engineering (p. 97)
- Master of Engineering in Construction Engineering and Management (p. 99)
- Master of Engineering in Energy Systems, Energy Conservation and Buildings Track (p. 99)
- Master of Engineering in Environmental Engineering (p. 101)
- Master of Engineering in Geotechnical Engineering (p. 101)
- Master of Engineering in Structural Engineering (p. 101)
- Master of Engineering in Transportation Engineering (p. 102)
- Master of Engineering in Urban Systems Engineering
 - Monitoring and Control of Urban Systems Track (p. 103)
 - Urban Building Systems Track (p. 103)
 - Urban Transportation Systems Track (p. 104)
- Master of Public Works (p. 105)
- Master of Science in Architectural Engineering (p. 107)
- Master of Science in Civil Engineering with specialization in: (p. 109)

Construction Engineering and Management
 Geotechnical Engineering
 Structural Engineering
 Transportation Engineering

- Master of Science in Environmental Engineering (p. 111)
- Doctor of Philosophy in Architectural Engineering (p. 111)
- Doctor of Philosophy in Civil Engineering (p. 112)
- Doctor of Philosophy in Environmental Engineering (p. 112)

Interdisciplinary Programs

- Master of Engineering in Environmental Engineering with Specialization in Energy/Environment/Economics (E3) (p. 113)
- Master of Science in Environmental Engineering with Specialization in Energy/Environment/Economics (E3) (p. 114)
- Doctor of Philosophy in Environmental Engineering with Specialization in Energy/Environment/Economics (E3) (p. 116)

Certificate Program in Architectural Engineering

- Architectural Engineering (p. 118)

Certificate Programs in Civil Engineering

- Construction Management (p. 118)
- Earthquake and Wind Engineering Design (p. 119)
- Infrastructure Engineering and Management (p. 119)
- Transportation Systems Planning (p. 121)

Certificate Programs in Environmental Engineering

- Air Resources (p. 118)
- Hazardous Waste Engineering (p. 119)
- Indoor Air Quality (p. 120)
- Water and Wastewater Treatment (p. 121)

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 with min. grade of C or MMAE 501* with min. grade of C or CAE 514* with min. grade of C, 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 with min. grade of C

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 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 with min. grade of C

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 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 Information Modeling Applications for Building Performance**

Building Information Modeling (BIM) is at the core of building performance optimization and sustainability, making it possible to model performance while tracking construction of the building in sequence. This course builds essential knowledge of building performance optimization using BIM processes and provides the necessary background and skills to use BIM with building energy simulation software tools. Autodesk Revit with Insight will be used as the primary design authoring, manipulation, and analysis tool. Secondary Autodesk BIM tools such as Formit for building massing and orientation; recap for existing conditions capturing; Navisworks for interference checking and design collaboration; revit Live for Virtual Reality visualizations and presentations; and BIM 360 Ops for facility management and operation will also be used in class. Proven methods for using BIM to address essential building performance and sustainability issues will be presented using real-world examples, placing particular emphasis on using BIM for analysis of design alternatives for the life cycle of a building. Complete with coverage of sustainability, integrated design, and lean construction requirements, this is a valuable course for architects, architectural engineers, MEP engineers, facility managers, and other construction professionals involved in building performance modeling and optimization.

Lecture: 3 Lab: 0 Credits: 3

CAE 517**HVAC Systems Design**

Study of the fundamental principles and engineering procedures for the design of heating, ventilating, and air conditioning systems; HVAC system characteristics; system and equipment selection; duct design and layout. Attention is given to energy conservation techniques and computer applications.

Prerequisite(s): CAE 331 or CAE 513 with min. grade of C

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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

CAE 519**Structural Forensic Engineering**

Introduction to structural forensic engineering as relates to civil and architectural engineering. Application of engineering principles to failure investigations including understanding the causes of failures, and safety issues at collapsed sites. Field investigations and data gathering including the use of sensor technology, sampling, and structural monitoring. Understanding the effects of the environment on the properties of common structural materials. Evaluation of distress conditions such as vibrations, cracks, metal fatigue, excessive deformation resulting from creep and inelasticity, thermal effects, fire damage, effects of extreme loading conditions, and localized failures. Preparation of forensic reports, presenting results of evaluations of failed structural systems and structural distress conditions, insurance/legal issues, responsibility of engineer and ethics issues. Review of case studies.

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 431 with min. grade of C and CAE 411 with min. grade of C

Lecture: 4 Lab: 0 Credits: 4

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 with min. grade of C

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 with min. grade of C

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* with min. grade of C, 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 with min. grade of C or CAE 513 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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* with min. grade of C, 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 with min. grade of C or MMAE 501 with min. grade of C or CAE 514 with min. grade of C

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 538**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 331 or CAE 513 with min. grade of C or MMAE 322

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 550**Applied Building Energy Modeling**

This course introduces students to building energy modeling software and techniques that are widely used in industry applications. The course is practice-oriented and builds upon building energy modeling methods as they are practiced in engineering offices (using IES software). The course centers on the two most common types of energy models in practice: (1) models for LEED and code compliance, and (2) parametric models for evaluating energy conservation measures. During the first half of the course, students will learn modeling methods and assumptions to create an energy model of an actual building project for the LEED Energy and Atmosphere credit with all supporting documents required for LEED submission. In the second half of the course, students will learn to analyze energy conservation measures using parametric energy models. The course will also focus on advanced energy modeling topics, such as modeling HVAC systems and controls, passive techniques, composite fenestration, thermal bridges, thermal mass, and others. At the end of the course, students will have two complete energy models that they can use in their portfolio.

Prerequisite(s): CAE 513 with min. grade of C

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* with min. grade of C, 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 environmental quality measurements in buildings including experimental design, data analysis, and experimental statistics. Measurements and techniques covered include: thermal performance (e.g., temperature, humidity, and heat flux); fluid flows and HVAC characteristics (e.g., velocity, pressure, and airflow rates); energy performance (e.g., current, voltage, and power draw); whole building diagnostics (e.g., envelope airtightness, ventilation performance, and duct leakage testing); and indoor air quality (e.g., tracer gas techniques, particle measurements, and gas measurements). Course combines lectures and field measurements in buildings on campus.

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 558**Urban Systems Engineering Design**

CAE 558 is a project-based course where students will explore integrated designs of urban systems. Each project will apply the students' engineering disciplines (such as structures, transportation, building science, construction engineering and management, environmental engineering) in a comprehensive analysis that considers the economic, human, and environmental issues associated with the project.

Lecture: 3 Lab: 0 Credits: 3

CAE 559**Urban Systems Engineering Seminar**

CAE 559 is an active seminar course that emphasizes current topics in urban systems engineering. Invited speakers will include researchers and representatives from current practice such as municipal and regional planners and consultants. Appropriate readings will be assigned in advance of each speaker to guide students in preparation for active discussion with each speaker. Each student will also write a term paper on an urban systems engineering topic of their choice, connecting material from the assigned reading, the speakers, and additional references selected by the student.

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* with min. grade of C and CAE 503* with min. grade of C, 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 with min. grade of C

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.

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 with min. grade of C and CAE 562* with min. grade of C, 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 with min. grade of C 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 with min. grade of C

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 with min. grade of C and CAE 420 with min. grade of C

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 569**Construction Methods, Cost Estimating, and Project Budgeting**

The role of program management and project budgeting in establishing a construction project, estimating in construction design and contract administration. Types of estimates, unit costs and production rates; job costs. Preparing bid for complete building project using manual methods and the CSI format; checking quantity take-off and cost estimating in selected divisions using a computer package. (2-3-3) (D)

Lecture: 2 Lab: 3 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 576**Applications of Unmanned Aerial Vehicles (UAVs or "Drones") for Construction Projects**

This course will introduce knowledge on Unmanned Aerial Systems (UAS) for construction projects. UAS are systems, such as Unmanned Aerial Vehicles (UAVs) that require a level of autonomy with minimal or no intervention from project actors to navigate over job-site environments. Instruction and learning activities incorporate all steps of processing UAV information. Laboratory activities include the design of plans to collect, analyze, and draw conclusions from UAV data and the sharing of experimental results with peers and faculty. Students will have access to a university-provided UAV equipped with advanced software for image processing, high-definition video camera, data communication platforms, and positioning sensors to capture a physical environment and register telemetry data related to their projects.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C and CAE 432 with min. grade of C

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 with min. grade of C

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 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

ENGR 502**Medical Device Regulations and Commercialization**

This course helps prepare students for commercializing medical devices within a highly-regulated environment. Concepts include protecting intellectual property, the structure and scope of the Federal Drug Administration (FDA), developing, testing, producing and marketing medical devices under FDA regulations, total product lifecycle, and quality management.

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

ENGR 510**Strategic Engineering Management**

This course will review technology-based enterprises and the driving forces that impact corporate strategy. Students will learn how to apply engineering knowledge to determine technology/product direction and make/buy/partnering decisions. Relationships between research and development, operations, finance, marketing, and other functions within engineering-based organizations that drive strategic decisions will be examined. Strategy development and competitive analysis will be included. Case studies from the industry relevant to the student's engineering track will be reviewed.

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

ENGR 520**Best Practices in Engineering Project Management**

Many engineering projects suffer due to weak business cases, schedule slippages, and cost overruns. This course presents commonly used tools and techniques and best practices to build an effective business case, develop a realistic schedule and budget, and successfully execute and complete a project. Students are introduced to a generic project management life cycle model, review basic project management principles, tools, and techniques, and learn engineering-tailored best practices used by high performing, project-centric organizations. Students have an opportunity to apply selected tools in the form of short classroom exercises.

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

ENGR 521**Risk Management in Engineering Projects**

In project management, a risk is considered an uncertain event that may have a positive or a negative impact on project objectives. Managing identified threats individually through customized strategies is key to project success. Similarly, opportunities must be leveraged for better project outcomes. Implementation of an effective risk management process is imperative for today's complex projects. This course presents a five-step process to manage project threats as well as opportunities. On every project, students will be able to identify and analyze risks and develop response strategies for each identified risk and take proper response action to manage the risks. Industry best practices and quantitative tools and simulations are used to analyze risk.

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

ENGR 531**Urban Systems Engineering Design**

ENGR 531 is a project-based course where students will explore integrated designs of urban systems. Each project will apply the students' engineering disciplines (such as structures, transportation, building science, construction engineering and management, environmental engineering) in a comprehensive analysis that considers the economic, human, and environmental issues associated with the project.

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

ENGR 532**Urban Systems Engineering Seminar**

ENGR 532 is an active seminar course that emphasizes current topics in urban systems engineering. Invited speakers will include researchers and representatives from current practice, such as municipal and regional planners and consultants. Appropriate readings will be assigned in advance of each speaker to guide students in preparation for active discussion with each speaker. Each student will also write a term paper on an urban systems engineering topic of their choice, connecting material from the assigned reading, the speakers, and additional references selected by the student.

Lecture: 3 Lab: 0 Credits: 3

ENGR 534**Product Design and Innovation**

This course covers all aspects of planning new products or services that are commercially viable and add to a company's suite of offerings. It includes such topics as user research, market analysis, need/problem identification, creative thinking, ideation, concepting, competitive benchmarking, human factors, prototyping, evaluation, and testing. The course includes creative, analytical, and technical skills in a balanced approach using such teaching methods as case studies, individual exercises, and group projects.

Lecture: 3 Lab: 0 Credits: 3

ENGR 539**Robotic Motion Planning**

Configuration space. Path planning techniques including potential field functions, roadmaps, cell decomposition, and sampling-based algorithms. Kalman filtering. Probabilistic localization techniques using Bayesian methods. Trajectory planning.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 573**Construction Contract Administration**

Characteristics of the construction industry. Project delivery systems. Duties and liabilities of the parties at the pre-contract stage. Bidding. Contract administration including duties and liabilities of the parties regarding payments, retainage, substantial and final completion, scheduling and time extensions, change orders, changed conditions, suspension of work, contract termination, and resolution of disputes. Contract bonds. Managing the construction company. Labor law and labor relations.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 575**Systems Analysis in 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

ENGR 576**Nano Manufacturing**

This course covers the general methods used for micro- and nano-fabrication and assembly, including photolithography techniques, physical and chemical deposition methods, masking, etching, and bulk micromachining as well as self-assembly techniques. It also covers nanotubes, nanowires, nanoparticles, and the devices that use them, including both electronic and mechanical-electronic systems, as well as nano-structural materials and composites. Focus is on commercially available current processes as well as emerging technologies and evolving research areas. Sensing and instrumentation as well as nano-positioning and actuation are covered briefly.

Lecture: 3 Lab: 0 Credits: 3

ENGR 587**Introduction to Digital Manufacturing**

This course is about the digital revolution taking place in the world of manufacturing and how students, workers, managers, and business owners can benefit from the sweeping technological changes taking place. It is about the change from paper-based processes to digital-based processes all through the design/manufacturing/deliver enterprise, and across the global supply chain. It touches on digital design, digital manufacturing engineering, digital production, digital quality assurance, and digital contracting, from large companies to small. There is also a significant focus on cyber security and the new types of threats that manufacturers face in the new digital world. Other topics covered include intelligent machines, connectivity, the digital thread, big data, and the Industrial Internet of Things (IIoT).

Lecture: 3 Lab: 0 Credits: 3

ENGR 588**Additive Manufacturing**

This course examines the fundamentals of a variety of additive manufacturing processes as well as design for additive manufacturing, materials available, and properties and limitations of materials and designs. It also examines the economics of additive manufacturing as compared to traditional subtractive manufacturing and other traditional techniques. Additive techniques discussed include 3D printing, selective laser sintering, stereo lithography, multi-jet modeling, laminated object manufacturing, and others. Advantages and limitations of all current additive technologies are examined as well as criteria for process selection. Processes for metals, polymers, and ceramics are covered. Other topics include software tools and connections between design and production, direct tooling, and direct manufacturing. Current research trends are discussed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 592**Engineering Management Capstone Experience**

Students apply the knowledge they have acquired in the Engineering Management program to a specific problem or case study. Projects will be identified and mentored in conjunction with faculty and industrial partners. A final report or business plan is required that reflects the focus of the capstone project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 595**Product Development for Entrepreneurs**

Elements of product development (mechanical and electrical), manufacturing and production planning, supply chain, marketing, product research, and entrepreneurship concepts are taught in this class. In this course, student teams will be required to create a compelling product that has potential to be sold in today's marketplace. They will be required to create functional prototypes of their product for people to use and critique. If successful, students will be allowed to put their product on Kickstarter.com and take orders for delivery after the class is complete while potentially fostering their own business as a result of this course.

Lecture: 3 Lab: 0 Credits: 3

ENGR 596**Practical Engineering Training**

This course is a mentored, immersive practical engineering training. Students learn under the direction of professional engineers and practicing engineers by working on real engineering projects. The student will perform hands-on engineering, including learning and developing/applying engineering principles and concepts to complete the project assigned to the student. The student will apply engineering ethics and safety during their practical engineering training. Students will communicate the results of their work in written and oral communications. Students will receive assignments of varying complexity consistent with their graduate standing.

Lecture: 0 Lab: 9 Credits: 3

ENGR 598**Graduate Research Immersion: Team Project**

This course provides a faculty-mentored immersive team-based research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

ENGR 599**Graduate Research Immersion: Individual**

This course provides a faculty-mentored immersive research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

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 503**Introduction to Occupational and Environmental Health and Safety**

This course is intended to introduce students to the basics of occupational and environmental safety and health. Topics include fundamental principles in industrial hygiene and occupational and environmental safety based in the anticipation, recognition, evaluation, and control of chemical, biological, physical, and ergonomic hazards that can be encountered in the workplace and other settings. Applications include indoor air pollution control, natural disaster mitigation, and infectious disease transmission and control.

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, stoichiometry, 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* with min. grade of C or ENVE 542* with min. grade of C, 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* with min. grade of C or ENVE 542* with min. grade of C, 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 pollution; 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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

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 four of which may be a special project course—CAE 594, 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 is a coursework-only degree program oriented toward students who wish to develop more knowledge about the design, construction, and operation of buildings and their systems. The degree program is intended for preparation for engineering practice. Students are required to specialize in one field of concentration: Building Systems, Construction Management, or Structures. Students with a variety of academic backgrounds are eligible to apply for the program, including those with undergraduate degrees in engineering disciplines (e.g., architectural, civil, mechanical, environmental, and others) and non-engineering disciplines (e.g., architecture, construction management, environmental science, and others).

Students specializing in the Building Systems concentration are expected to have passed thermodynamics and fluid mechanics in their undergraduate studies. Students specializing in the Structures concentration are expected to have passed steel design and concrete design. If students have not passed these courses, they may be required to take deficiency courses in their first year of study or in the summer before their first year of study. Each applicant will be evaluated on a case-by-case basis during the application review process to determine any deficiency course requirements.

Curriculum

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level Credit	20
Minimum CAE Credit	24
Maximum Transfer Credit	9

Code	Title	Credit Hours
Core Courses		(6)
CAE 513	Building Science ¹	3
CAE 523	Statistical Analysis Engg Data ¹	3
Specialization Courses		(18)
Select a minimum of 18 credit hours in one field of concentration. See the Specializations tab on this page.		18
Elective Courses		(8-9)
Select eight to nine credit hours from any of the ARCE fields of concentration ²		8-9
Total Credit Hours		32-33

¹ Students who have previously passed an equivalent course in their prior degree programs may substitute another course for CAE 513 and/or CAE 523 with adviser and departmental approval.

² General background courses, or graduate courses offered by the College of Architecture, Engineering Graphics, or other relevant departments in the Armour College of Engineering may be chosen as electives with adviser and departmental approval.

Architectural Engineering Specializations

Students must complete 18 credit hours from one area of specialization (Building Systems, Construction Management, or Structures). Other courses may be accepted for the specialization requirement with adviser and departmental approval.

Building Systems

Code	Title	Credit Hours
Select a minimum of 18 credit hours from the following:		18
ARCH 551	Desn Energy-Efficient Bldg I	3
ARCH 552	Design of Energy-Eff Bldg II	3
CAE 422	Sprinklers Standpipes Fire Pum	3
CAE 425	Fire Protection & Life Safety	3
CAE 461	Plumbing/Fire Protection Dsgn	3
CAE 464	HVAC Systems Design	3

CAE 466	Building Electrical/Lighting	3
CAE 467	Lighting Systems Design	3
CAE 510	Dynamics of Fire	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 517	HVAC Systems Design	3
CAE 524	Building Enclosure Design	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CAE 527		3
CAE 550	Applied Bldg Energy Modeling	3
CAE 553	Measurement & Instrumentation	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3
CAE 575	Systems Analysis in Civil Engg	3
CAE 597	Special Problems	1-4
ENVE 576	Indoor Air Pollution	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 525	Fundamentals of Heat Transfer	3
Total Credit Hours		18

Construction Management

Code	Title	Credit Hours
Select a minimum 18 credit hours from the following:		18
ARCH 560	Intd Bldg Deliv Prac/BIM	3
CAE 470	Constrctn Methods&Cost Estmg	3
CAE 471	Construction Plan & Scheduling	3
CAE 472	Construction Site Operation	3
CAE 473	Construction Contract Admin	3
CAE 486	Soil Site Improvement	3
CAE 570	Legal Issues in Civil Engrg	3
CAE 571	Lean Construction and Control	3
CAE 572	Construction Cost Acctg&Cntrl	3
CAE 573	Construction Mgmt with BIM	3
CAE 574	Economic Decision Analysis	3
CAE 575	Systems Analysis in Civil Engg	3
CAE 577	Constuction Equip Management	3
CAE 578	Construction Claims Mgmt	3
CAE 579	Real Estate Fundamentals	3
CAE 597	Special Problems	1-4
Total Credit Hours		18

Structures

Code	Title	Credit Hours
Select a minimum of 18 credit hours from the following:		18
CAE 410	Intro to Wind/Earthquake Engg	3
CAE 435	Experimental Anlys Structures	3
CAE 436	Dsgn Masonry/Timber Structures	3
CAE 457	Geotechnical Foundation Dsgn	3
CAE 503	Advanced Structural Analysis	3
CAE 504	Seismic Retrofit/Earthquake	4
CAE 506	Building Env Rehab Engineering	3
CAE 518	Advanced Reinforced Concrete	3
CAE 520	Buckling of Structures	4

CAE 522	Structural Model Analysis	4
CAE 525	Advd Steel&Composite Structure	4
CAE 530	Finite Element Method of Anlys	3
CAE 532	Analysis of Plates and Shells	4
CAE 533	Theory & Anlys of Thin Shells	3
CAE 534	Computational Techniques	3
CAE 537	Homeland Security Concerns	3
CAE 551	Prestressed Concrete	3
CAE 560	Plastic Methods	4
CAE 561	Structural Reliability	3
CAE 564	Foundations/Embankments/Earth	4
CAE 575	Systems Analysis in Civil Engg	3
CAE 582	Structural Wind&Earthquake Eng	4
CAE 597	Special Problems	1-4

Total Credit Hours

18

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 four of which may be a special project course—CAE 594, 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

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

Master of Engineering in Energy Systems, Energy Conservation and Buildings Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
CHE 543	Energy Envir Economics	3
ECE 418	Power Systems Analysis	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
Energy Conservation and Buildings Courses		(12)
Select 12 credit hours from the following courses:		12
CAE 513	Building Science	3

CAE 524	Building Enclosure Design	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3
CHE 541	Renwble Enrgy Technologies	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3
MMAE 525	Fundamentals of Heat Transfer	3

Elective Courses (9)

Select nine credit hours from the following courses: ¹ 9

CAE 464	HVAC Systems Design	3
CAE 466	Building Electrical Sysys Dsgn	3
CAE 467	Lighting Systems Design	3
CAE 513	Building Science	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 524	Building Enclosure Design	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CAE 527	Congrol of Bldg Envnmtl Sysys	3
CAE 550	Applied Bldg Energy Modeling	3
CAE 553	Measurement & Instrumentation	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3
CHE 541	Renwble Enrgy Technologies	3
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 564	Cntrl Oprtn Elect Power Sysys	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3
ECE 597	Special Problems	1-3
MMAE 425	Direct Energy Conversion	3
MMAE 433	Design of Thermal Systems	3
MMAE 453	Adv Automotive Powertrains	3
MMAE 523	Fundamentals Power Generation	3
MMAE 525	Fundamentals of Heat Transfer	3

Total Credit Hours 30

¹ Course must not have been used to fulfill specialization course requirement.

Master of Engineering in Environmental Engineering 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 nine credit hours in courses numbered 400-499 may be selected in some cases to overcome deficiencies or broaden the student's background. Students may take up to four credit hours of a special project course—CAE 594, CAE 597, or ENVE 597. No thesis or comprehensive examination is required for completion of the degree.

Code	Title	Credit Hours
Core Courses		(15)
CAE 523	Statistical Analysis Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	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 four of which may be a special project course—CAE 594, 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

Code	Title	Credit Hours
Required Courses		(16)
CAE 562	Engineering Behavior of Soils	4
CAE 564	Foundations/Embankments/Earth	4
CAE 565	Rock Mechanics and Tunneling	4
CAE 566	Earthquake Engg/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 four of which may be a special project course—CAE 594, 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

Code	Title	Credit Hours
Core Courses		(13)
MMAE 501	Engineering Analysis I	3
or CAE 514	Math Methods for Struct Engrng	
CAE 503	Advanced Structural Analysis	3
CAE 518	Advanced Reinforced Concrete	3
CAE 525	Advd Steel&Composite Structure	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 four of which may be a special project course—CAE 594, 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

Code	Title	Credit Hours
Core Courses		(12-13)
Select a minimum of four courses from the following with adviser consent:		12-13
CAE 523	Statistical Analysis Engg Data	3
CAE 543	Demand Models for Urban Trans	3
CAE 544	Urban Transportation Planning	4
CAE 546	Public Transportation Systems	3
CAE 548	Transportation Systems Mgnt	3
CAE 555	Transportation Systs Evaluatio	3
CAE 575	Systems Analysis in Civil Engg	3
MATH 525	Statistical Models and Methods	3
Project Course		(1-3)
CAE 594	Research Problems	1-3
or CAE 597	Special Problems	
General Electives		(17-18)
Select 17-18 credit hours from the following:		17-18
CAE 416	Facilty Dsgn Trnsprtn Syst	3
CAE 417	Railroad Engineering & Design	3
CAE 419	Intro Transportation Engg/Dsgn	3
CAE 430	Probability Cncpt Ce Dsgn	3
CAE 508	Advanced Bridge Engineering	3
CAE 539	Intro to Geographic Info Systs	3
CAE 541	Pavement Evaluation&Management	3
CAE 545	Traffic Operations & Flow Thry	3
CAE 547	Advanced Traffic Engineering	3
CAE 549	Transportation Econ, Dev&Plcy	3
CAE 568	Transportation Asset Mgnt	3
CAE 574	Economic Decision Analysis	3
CAE 580	Intelligent Transport 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 Fin	3
MATH 571	Data Preparation and Analysis	3
MATH 574	Bayesian Computational Stats	3

Minimum degree credits required: 32

Master of Engineering in Urban Systems Engineering, Monitoring and Control of Urban Systems Track

Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CAE 523	Statistical Analysis Engg Data	3
CAE 558/ENGR 531	Urban Systems Engg Design	3
CAE 559/ENGR 532	Urban Systems Engg Seminar	3
CAE 574	Economic Decision Analysis	3
CAE 575	Systems Analysis in Civil Engg	3
CHE 543	Energy Envir Economics	3
Monitoring and Control of Urban Systems Courses		(12)
CAE 527	Congrol of Bldg Envmntl Sysys	3
CAE 580	Intelligent Transport Systems	3
ECE 504	Wireless Comm Systm Design	3
MMAE 543	Modern Control Systems	3
Total Credit Hours		30

Master of Engineering in Urban Systems Engineering, Urban Building Systems Track

Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CAE 523	Statistical Analysis Engg Data	3
CAE 558/ENGR 531	Urban Systems Engg Design	3
CAE 559/ENGR 532	Urban Systems Engg Seminar	3
CAE 574	Economic Decision Analysis	3
CAE 575	Systems Analysis in Civil Engg	3
CHE 543	Energy Envir Economics	3
Urban Building Systems Courses		(12)
Select 12 credit hours from the following courses:		12
CAE 513	Building Science	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CAE 527	Congrol of Bldg Envmntl Sysys	3
CAE 550	Applied Bldg Energy Modeling	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3

MMAE 515

Engineering Acoustics

3

Total Credit Hours

30

Master of Engineering in Urban Systems Engineering, Urban Transportation Systems Track

Curriculum

Code	Title	Credit Hours
Core Courses		(18)
CAE 523	Statistical Analysis Engg Data	3
CAE 558/ENGR 531	Urban Systems Engg Design	3
CAE 559/ENGR 532	Urban Systems Engg Seminar	3
CAE 574	Economic Decision Analysis	3
CAE 575	Systems Analysis in Civil Engg	3
CHE 543	Energy Envir Economics	3
Urban Transportation Systems Courses		(12)
Select 12 credit hours from the following courses:		12
CAE 543	Demand Models for Urban Trans	3
CAE 544	Urban Transportation Planning	4
CAE 546	Public Transportation Systems	3
CAE 548	Transportation Systems Mgmt	3
CAE 549	Transportation Econ, Dev&Plcy	3
CAE 555	Transportation Sysys Evaluatio	3
CAE 568	Transportation Asset Mgmt	3
ECE 512	Hybrid Electric Vehicle Drives	3
ECE 544	Wireless and Mobile Networks	3
Total Credit Hours		30

Master of Engineering Management, Project Management Track

Curriculum

Code	Title	Credit Hours
Core Courses		(15)
EMGT 470	Project Management	3
CAE/ENGR 574	Economic Decision Analysis	3
CAE/ENGR 575	Systems Analysis in Civil Engg	3
ENGR 510	Strategic Engineering Mgmt	3
ENGR 592	Engg Management Capstone Exp	3
Project Management Courses		(9)
Select nine credit hours from the following courses:		9
CAE 421/ENGR 521	Risk Assessment Engrg	3
CAE 473/ENGR 573	Construction Contract Admin	3
CAE/ENGR 572	Construction Cost Acctg&Cntrl	3
ENGR 520	Best Practices Engg Proj Mgmt	3
ENGR 521	Risk Mgmt in Engg Projects	3
INTM 511	Industrial Leadership	3
MBA 523	Negotiations & Strat Dec Mkng	3
Elective Courses		(6)
Select six credit hours from any 500-level BME, CHE, CAE, ECE, EG, ENVE, or MMAE engineering course.		6
Total Credit Hours		30

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, five to six elective courses, and one CAE 597 or CAE 594 special problems course (up to four credit hours). 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

Code	Title	Credit Hours
Core Courses		(12)
CAE 574	Economic Decision Analysis	3
CAE 575	Systems Analysis in Civil Engg	3
PA 501	Introduction to Public Admin	3
PA 551	Public Infrastructure Mgmt	3
Electives		(17-18)
Select 17-18 credit hours (see recommended courses below)		17-18
CAE Special Problems Course		(1-3)
CAE 594	Research Problems	1-3
or CAE 597	Special Problems	

Minimum degree credits required: 32

Recommended Elective Coursework by Subject

Construction Management

Code	Title	Credit Hours
CAE 470	Constructn Methods&Cost Estmg	3
CAE 471	Construction Plan & Scheduling	3
CAE 472	Construction Site Operation	3
CAE 473	Construction Contract Admin	3

Geotechnical Engineering

Code	Title	Credit Hours
CAE 482	Hydraulic Dsgn Open Chnnl Syst	3
CAE 486	Soil Site Improvement	3
CAE 562	Engineering Behavior of Soils	4
CAE 564	Foundations/Embankments/Earth	4
CAE 565	Rock Mechanics and Tunneling	4
CAE 566	Earthquake Engg/Soil Dynamics	4
CAE 589	Groundwater Hydrology/Sampling	3
CAE 590	Geotechnical Landfill Design	3
ENVE 404	Water & Wastewater Engineering	3
ENVE 551	Industrial Waste Treatment	3

Public Administration - Administration Process

Code	Title	Credit Hours
PA 502	Organizational Behavior	3
PA 503	Administration Law	3
PA 522	Human Resource Management	3
PA 532	Public Financial Management	3
PA 533	Adv Financial Management	3

Public Administration - Policy Planning

Code	Title	Credit Hours
PA 537	Crisis Mgmt/Homeland Security	3
PA 538	Info Syst Security/Cyber Crime	3
PA 539	Local Government Mgmt	3
PA 562	Urban and Metropolitan Gov	3
PA 578	Plan,Policy Making&Bult Envir	3
PA 588	Incident Rspnse Disaster Rcvry	3

Structural Engineering

Code	Title	Credit Hours
CAE 504	Seismic Retrofit/Earthquake	4
CAE 506	Building Env Rehab Engineering	3
CAE 508	Advanced Bridge Engineering	3
CAE 518	Advanced Reinforced Concrete	3
CAE 520	Buckling of Structures	4
CAE 525	Advd Steel&Composite Structure	4
CAE 551	Prestressed Concrete	3

Transportation Engineering

Code	Title	Credit Hours
CAE 419	Intro Transportation Engg/Dsgn	3
CAE 523	Statistical Analysis Engg Data	3
CAE 540	Asphalt Concrete Mix Design	3
CAE 541	Pavement Evaluation&Management	3
CAE 544	Urban Transportation Planning	4
CAE 545	Traffic Operations & Flow Thry	3
CAE 546	Public Transportation Systems	3
CAE 547	Advanced Traffic Engineering	3
CAE 548	Transportation Systems Mgmt	3
CAE 549	Transportation Econ, Dev&Plcy	3
CAE 555	Transportation Sysys Evaluatio	3
CAE 568	Transportation Asset Mgmt	3
CAE 574	Economic Decision Analysis	3
CAE 580	Intelligent Transport 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 Fin	3
MATH 571	Data Preparation and Analysis	3
MATH 574	Bayesian Computational Stats	3

Master of Science in Architectural Engineering

The Master of Science in Architectural Engineering is a research and thesis-based degree program oriented toward students who wish to develop more knowledge about the design, construction, and operation of buildings and their systems. Students are required to specialize in one field of concentration: Building Systems, Construction Management, or Structures.

Students are expected to conduct research at a rigorous level above and beyond the coursework-only Master of Engineering in Architectural Engineering degree program. The program also serves as a foundation for research for students who intend to pursue a doctoral degree. Students with a variety of academic backgrounds are eligible to apply for the program, including those with undergraduate degrees in engineering disciplines (e.g. architectural, civil, mechanical, environmental, and others) and non-engineering disciplines (e.g. architecture, construction management, environmental science, and others).

Students specializing in the Building Systems concentration are expected to have passed thermodynamics and fluid mechanics in their undergraduate studies. Students specializing in the Structures concentration are expected to have passed steel design and concrete design. If students have not passed these courses, they may be required to take deficiency courses in their first year of study or in the summer before their first year of study. Each applicant will be evaluated on a case-by-case basis during the application review process to determine any deficiency course requirements.

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.

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level Credit	20
Minimum CAE Credit	24
Maximum Transfer Credit	9

Code	Title	Credit Hours
Required Courses		(6)
CAE 513	Building Science ¹	3
CAE 523	Statistical Analysis Engg Data ¹	3
Thesis Research		(6-8)
CAE 591	Research and Thesis M.S.	6-8
Specialization Electives		(18)
Select a minimum of 18 credit hours in one field of concentration. See the Specializations tab on this page.		18
Elective Courses		(0-2)
Select zero to two credit hours from any of the ARCE fields of concentration ²		0-2

¹ Students who have previously passed an equivalent course in their prior degree programs may substitute another course for CAE 513 and/or CAE 523 with adviser and departmental approval.

² General background courses, or graduate courses offered by the College of Architecture, Engineering Graphics, or other relevant departments in the Armour College of Engineering may be chosen as electives with adviser and departmental approval.

Architectural Engineering Specializations

Students must complete 18 credit hours from one area of specialization (Building Systems, Construction Management, or Structures). Other courses may be accepted for the specialization requirement with adviser and departmental approval.

Building Systems

Code	Title	Credit Hours
Select a minimum of 18 credit hours from the following:		18
ARCH 551	Desn Energy-Efficient Bldg I	3
ARCH 552	Design of Energy-Eff Bldg II	3
CAE 422	Sprinklers Standpipes Fire Pum	3
CAE 425	Fire Protection & Life Safety	3

CAE 461	Plumbing/Fire Protection Dsgn	3
CAE 464	HVAC Systems Design	3
CAE 466	Building Electrical/Lighting	3
CAE 467	Lighting Systems Design	3
CAE 510	Dynamics of Fire	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 517	HVAC Systems Design	3
CAE 524	Building Enclosure Design	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CAE 527		3
CAE 550	Applied Bldg Energy Modeling	3
CAE 553	Measurement & Instrumentation	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3
CAE 575	Systems Analysis in Civil Engg	3
CAE 597	Special Problems	1-20
ENVE 576	Indoor Air Pollution	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 525	Fundamentals of Heat Transfer	3

Total Credit Hours 18

Construction Management

Code	Title	Credit Hours
Select a minimum 18 credit hours from the following:		18
ARCH 560	Intd Bldg Deliv Prac/BIM	3
CAE 470	Constrctn Methods&Cost Estmg	3
CAE 471	Construction Plan & Scheduling	3
CAE 472	Construction Site Operation	3
CAE 473	Construction Contract Admin	3
CAE 486	Soil Site Improvement	3
CAE 570	Legal Issues in Civil Engrg	3
CAE 571	Lean Construction and Control	3
CAE 572	Construction Cost Acctg&Cntrl	3
CAE 573	Construction Mgmt with BIM	3
CAE 574	Economic Decision Analysis	3
CAE 575	Systems Analysis in Civil Engg	3
CAE 577	Constuction Equip Management	3
CAE 578	Construction Claims Mgmt	3
CAE 579	Real Estate Fundamentals	3
CAE 597	Special Problems	1-20

Total Credit Hours 18

Structures

Code	Title	Credit Hours
Select a minimum of 18 credit hours from the following:		18
CAE 410	Intro to Wind/Earthquake Engg	3
CAE 435	Experimental Anlys Structures	3
CAE 436	Dsgn Masonry/Timber Structures	3
CAE 457	Geotechnical Foundation Dsgn	3
CAE 503	Advanced Structural Analysis	3
CAE 504	Seismic Retrofit/Earthquake	4
CAE 506	Building Env Rehab Engineering	3

CAE 518	Advanced Reinforced Concrete	3
CAE 520	Buckling of Structures	4
CAE 522	Structural Model Analysis	4
CAE 525	Advd Steel&Composite Structure	4
CAE 530	Finite Element Method of Anlys	3
CAE 532	Analysis of Plates and Shells	4
CAE 533	Theory & Anlys of Thin Shells	3
CAE 534	Computational Techniques	3
CAE 537	Homeland Security Concerns	3
CAE 551	Prestressed Concrete	3
CAE 560	Plastic Methods	4
CAE 561	Structural Reliability	3
CAE 564	Foundations/Embankments/Earth	4
CAE 575	Systems Analysis in Civil Engg	3
CAE 582	Structural Wind&Earthquake Eng	4
CAE 597	Special Problems	1-20

Total Credit Hours

18

Master of Science in Civil Engineering

Four technical areas (construction, 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

Construction Engineering and Management Emphasis

Code	Title	Credit Hours
Required Courses		(12)
CAE 570	Legal Issues in Civil Engrg	3
CAE 571	Lean Construction and Control	3
CAE 574	Economic Decision Analysis	3
CAE 577	Constuction Equip Management	3
Elective Courses		(12-14)
Select 12-14 credit hours		12-14
Thesis Research		(6-8)
CAE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

Geotechnical Engineering Emphasis

Code	Title	Credit Hours
Required Courses		(16)
CAE 562	Engineering Behavior of Soils	4
CAE 564	Foundations/Embankments/Earth	4
CAE 565	Rock Mechanics and Tunneling	4
CAE 566	Earthquake Engg/Soil Dynamics	4
Elective Courses		(8-10)
Select 8-10 credit hours		8-10
Thesis Research		(6-8)
CAE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

Structural Engineering Emphasis

Code	Title	Credit Hours
Required Courses		(13)
MMAE 501	Engineering Analysis I	3
or CAE 514	Math Methods for Struct Engrng	
CAE 503	Advanced Structural Analysis	3
CAE 518	Advanced Reinforced Concrete	3
CAE 525	Advd Steel&Composite Structure	4
Elective Courses		(11-13)
Select 11-13 credit hours		11-13
Thesis Research		(6-8)
CAE 591	Research and Thesis M.S.	6-8

Minimum degree credits required: 32

Transportation Engineering Emphasis

Code	Title	Credit Hours
Required Courses		(12-13)
Select a minimum of four courses from the following (with adviser consent):		12-13
CAE 523	Statistical Analysis Engg Data	3
CAE 543	Demand Models for Urban Trans	3
CAE 544	Urban Transportation Planning	4
CAE 546	Public Transportation Systems	3
CAE 548	Transportation Systems Mgmt	3
CAE 555	Transportation Sysys Evaluatio	3
CAE 575	Systems Analysis in Civil Engg	3
MATH 525	Statistical Models and Methods	3
Thesis Research		(6-8)
CAE 591	Research and Thesis M.S.	6-8
Elective Courses		(12-14)
Select 12-14 credit hours from the following: ¹		12-14
CAE 419	Intro Transportation Engg/Dsgn	3
CAE 540	Asphalt Concrete Mix Design	3
CAE 541	Pavement Evaluation&Management	3
CAE 545	Traffic Operations & Flow Thry	3
CAE 547	Advanced Traffic Engineering	3
CAE 549	Transportation Econ, Dev&Plcy	3
CAE 568	Transportation Asset Mgmt	3
CAE 574	Economic Decision Analysis	3
CAE 580	Intelligent Transport 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 Fin	3
MATH 571	Data Preparation and Analysis	3
MATH 574	Bayesian Computational Stats	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

Code	Title	Credit Hours
Core Courses		(15)
CAE 523	Statistical Analysis Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 580	Hazardous Waste Engineering	3
Elective Courses		(9-11)
Select 9-11 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 courses. Aside from the core courses, coursework may be selected (with adviser approval) to satisfy the needs of the individual student.

Up to nine 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 six to eight 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 Architectural Engineering

The objective of the Doctor of Philosophy in Architectural Engineering program is to provide a unique avenue for the advanced study of the design, construction, and operation of buildings and their systems. Students can specialize in any relevant aspect of Architectural Engineering in which CAEE faculty members have expertise, which includes: building energy and environmental systems, structures, or construction engineering and management. Through state-of-the-art and original research, students are expected to achieve a high level of mastery in the study of buildings and their systems, which should be demonstrated by successful defense of their dissertation and the publication of novel research results in peer-reviewed academic journals. Students who earn a Doctor of Philosophy in Architectural Engineering will be prepared for careers in both academia and industrial research and development. The program is intended for students with bachelor's or master's degrees in architectural engineering, civil engineering, mechanical engineering, or other related disciplines.

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

Code	Title	Credit Hours
Master of Science transfer coursework		(32)
Maximum amount eligible for transfer is 32 credit hours		32
Ph.D. Coursework		(16-28)
Select 16-28 credit hours of 500-level and above CAE, CS, ENVE, MATH, or MMAE courses. ¹		16-28
Ph.D. Research		(24-36)
CAE 691	Research and Thesis Ph.D.	24-36

¹ 400-level courses and courses in other disciplines may be chosen as electives with adviser and departmental approval.

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. 109).

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

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

Code	Title	Credit Hours
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 Ph.D.	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. 111).

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

Requirement		Credits
Minimum Credits Required		84
Maximum Transfer Credit		42

Code	Title	Credit Hours
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 Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	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 Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	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 three to six 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 CAE 589 as a Group B course option.

E3 Courses

See descriptions under the respective department's course listings.

Group A

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	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 zero to two 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 CAE 589 as a Group B course option.

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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 Envir Economics	3
Select five 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 CAE 589 as a Group B course option.

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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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.

Gainful Employment Disclosure for the Certificate in Air Resources

Curriculum

Code	Title	Credit Hours
Required Course		(3)
ENVE 570	Air Pollution Meteorology	3
Elective Courses		(9)
ENVE 576	Indoor Air Pollution	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
Total Credit Hours		12

Certificate in Architectural Engineering

Curriculum

Code	Title	Credit Hours
Required Courses		(3)
CAE 513	Building Science	3
Elective Courses		(6)
Select a minimum of two courses from the following:		6
CAE 461	Plumbing/Fire Protection Dsgn	3
CAE 464	HVAC Systems Design	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 524	Building Enclosure Design	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CAE 550	Applied Bldg Energy Modeling	3
CAE 553	Measurement & Instrumentation	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Architectural Engineering

Certificate in Construction Management

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
Select a minimum of four courses from the following:		12
CAE 470	Constrctn Methods&Cost Estmg	3
CAE 471	Construction Plan & Scheduling	3
CAE 472	Construction Site Operation	3
CAE 473	Construction Contract Admin	3
CAE 570	Legal Issues in Civil Engrg	3
CAE 571	Lean Construction and Control	3
CAE 572	Construction Cost Acctg&Cntrl	3
CAE 573	Construction Mgmt with BIM	3
CAE 574	Economic Decision Analysis	3

CAE 575	Systems Analysis in Civil Engg	3
CAE 577	Constuction Equip Management	3
CAE 578	Construction Claims Mgmt	3
CAE 579	Real Estate Fundamentals	3

Total Credit Hours 12

Gainful Employment Disclosure for Certificate in Construction Management

Certificate in Earthquake and Wind Engineering Design Curriculum

Code	Title	Credit Hours
Required Courses		(12-14)
Select a minimum of four courses from the following:		12-14
CAE 410	Intro to Wind/Earthquake Engg	3
CAE 518	Advanced Reinforced Concrete	3
CAE 525	Advd Steel&Composite Structure	4
CAE 582	Structural Wind&Earthquake Eng	4
CAE 583	PBSSD of Buildings and Bridges	3
CAE 586	Seismic Dsgn of Bldg&Brdg Str	3

Total Credit Hours 12-14

Gainful Employment Disclosure for Certificate in Earthquake and Wind Engineering Design

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.

Gainful Employment Disclosure for Certificate in Hazardous Waste Management

Curriculum

Code	Title	Credit Hours
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/Sampling	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3

Total Credit Hours 9

Certificate in Infrastructure Engineering and Management Curriculum

Code	Title	Credit Hours
Required Courses		(6)
PA 501	Introduction to Public Admin	3
PA 551	Public Infrastructure Mgmt	3

Elective Courses			(6)
Select a minimum of two courses from the following (with adviser consent):			6
CAE 408	Bridge Structural Design	3	
CAE 416	Facilty Dsgn Trnsprtn Syst	3	
CAE 417	Railroad Engineering & Design	3	
CAE 419	Intro Transportation Engg/Dsgn	3	
CAE 471	Construction Plan & Scheduling	3	
CAE 486	Soil Site Improvement	3	
CAE 508	Advanced Bridge Engineering	3	
CAE 523	Statistical Analysis Engg Data	3	
CAE 539	Intro to Geographic Info Systs	3	
CAE 541	Pavement Evaluation&Management	3	
CAE 544	Urban Transportation Planning	4	
CAE 546	Public Transportation Systems	3	
CAE 548	Transportation Systems Mgnt	3	
CAE 549	Transportation Econ, Dev&Plcy	3	
CAE 555	Transportation Systs Evaluatio	3	
CAE 568	Transportation Asset Mgmt	3	
CAE 574	Economic Decision Analysis	3	
CAE 575	Systems Analysis in Civil Engg	3	
CAE 581	Algorithms in Transportation	3	
CAE 590	Geotechnical Landfill Design	3	
Total Credit Hours			12

Gainful Employment Disclosure for Certificate in Infrastructure Engineering and Management

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.

Gainful Employment Disclosure for Certificate in Indoor Air Quality

Curriculum

Code	Title	Credit Hours
Required Course		
(3)		
ENVE 576	Indoor Air Pollution	3
Elective Courses		
(6)		
Select a minimum of two courses from the following:		
6		
BIOL 514	Toxicology	3
CAE 464	HVAC Systems Design	3
CAE 523	Statistical Analysis Engg Data	3
ENVE 506	Chemodynamics	3
Total Credit Hours		
9		

Certificate in Transportation Systems Planning Curriculum

Code	Title	Credit Hours
Select a minimum of two courses from the following (with adviser consent):		6
CAE 523	Statistical Analysis Engg Data	3
CAE 544	Urban Transportation Planning	4
CAE 546	Public Transportation Systems	3
CAE 548	Transportation Systems Mgmt	3
CAE 555	Transportation Sysys Evaluatio	3
CAE 575	Systems Analysis in Civil Engg	3
Select a minimum of two courses from the following (with adviser consent):		6
CAE 416	Facilty Dsgn Trnsprtn Syst	3
CAE 417	Railroad Engineering & Design	3
CAE 419	Intro Transportation Engg/Dsgn	3
CAE 539	Intro to Geographic Info Sysys	3
CAE 549	Transportation Econ, Dev&Plcy	3
CAE 568	Transportation Asset Mgmt	3
CAE 574	Economic Decision Analysis	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

Gainful Employment Disclosure for Certificate in Transportation Systems Planning

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.

Gainful Employment Disclosure for Water and Wastewater Treatment

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ENVE 501	Environmental Chemistry	3
ENVE 513	Biotech Processes in ENVE	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
Total Credit Hours		12

Electrical and Computer Engineering

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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. The Office of Digital Learning, 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

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

- Master's/Master of Science: 304 (quantitative + verbal), 3.5 (analytical writing)
- Ph.D.: 304 (quantitative + verbal), 3.5 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

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.

Degrees Offered

- Master of Biomedical Imaging and Signals (p. 140)
- Master of Computational Engineering, Optimization, Machine Vision, and Decision Making Track (p. 141)
- Master of Computer Engineering in Internet of Things
- Master of Cyber Security Engineering (p. 144)
- Master of Electrical and Computer Engineering (p. 145)
- Master of Network Engineering (p. 147)
- Master of Power Engineering (p. 149)
- Master of Telecommunications and Software Engineering (p. 150)
- Master of VLSI and Microelectronics (p. 152)
- Master of Engineering in Advanced Manufacturing, Automation and Control Systems Track (p. 153)
- Master of Engineering in Artificial Intelligence for Computer Vision and Control

- Master of Engineering in Energy Systems, Energy Transmission and Markets Track (p. 156)
- Master of Engineering in Wireless Communications and Computer Networks
- Master of Science in Computer Engineering (p. 158)
- Master of Science in Electrical Engineering (p. 167)
- Doctor of Philosophy in Computer Engineering (p. 170)
- Doctor of Philosophy in Electrical Engineering (p. 172)

Dual Degree Program

- Master of Science in Computer Engineering and Electrical Engineering (p. 161)

Joint Degree Programs

- Master of Electricity Markets (with Finance (p. 146))

Interdisciplinary Programs

- Master of Electrical and Computer Engineering with Specialization in Energy/Environment/Economics (E3) (p. 172)
- Master of Science in Electrical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 174)
- Doctor of Philosophy in Electrical Engineering with Specialization in Energy/Environment/Economics (E3) (p. 179)

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. 181)
- Applied Electromagnetics (p. 181)
- Communication Systems (p. 182)
- Computer Engineering (p. 182)
- Control Systems (p. 183)
- Electricity Markets (p. 184)
- Power Electronics (p. 184)
- Power Engineering (p. 185)
- Signal Processing (p. 186)
- Wireless Communications Engineering (p. 186)

Course Descriptions

ECE 501

Artificial Intelligence and Edge Computing

This course introduces methods in designing contemporary smart systems utilizing artificial intelligence, machine vision, and their applications. Topics include linear regression, logistic regression, multilayer neural networks, supervised/unsupervised learning, convolutional networks, and recurrent neural networks. This course also covers topics in deep learning algorithms and artificial intelligence structures optimized for low power embedded computing platforms (Edge Artificial Intelligence) with applications in machine vision, robotics, internet of things, smart grids and autonomous systems. In addition, students are required to complete an open-ended design project in one of the advanced topics, for example, numerical in Deep Neural Networks, Convolutional Networks, and Recurrent Neural Networks.

Prerequisite(s): ECE 242 and MATH 374 and ECE 308

Lecture: 3 Lab: 0 Credits: 3

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 503

5G Wireless Network: Architecture, New Radio, and Security

The primary distinguishing features of 5th Generation (5G) wireless network are its operations in the mm wave region for effectively handling Machine Type Communication (MTC) for supporting secure and tactile Internet of Things (IoT) and cloud based virtualization and operations. This course covers the details of 5G Cloud based Radio Access Network (C-RAN) and the 5G Core along with how the cloud infrastructure creates a very powerful flexible, secure, and reliable network through virtualization and Network Slicing. Unique features of 5G New Radio (NR) including accessing and duplexing schemes, mm wave operation, and enhanced coverage are discussed. The capabilities of the 5G Core which provides a very flexible usage of network resources are discussed. Projects will entail application to a selected set of use cases in the domains of smart city, smart transportation, and e-Health among others.

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.

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 Processing and 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.

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 510**Internet of Things and Cyber Physical Systems**

To introduce students to the fundamentals of Internet of Things (IoT) and embedded computing. This course covers IoT applications, Wireless protocols, Wearable sensors, Home environment sensors, Behavior detection sensors, Data fusion, processing and analysis, Data communications, Architectural design issues of IoT layers, Security and privacy issues in IoT. Simulation mini-projects and lab experiments are based on the lectures given.

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 512**Hybrid Electric Vehicle Drives**

Fundamentals of electric motor drives are studied. Applications of semiconductor switching circuits to adjustable speed drives, robotic, and traction are explored. Selection of motor drives, calculating the ratings, speed control, position control, starting, and braking are also covered. Simulation mini-projects and lab experiments are based on the lectures given.

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 with min. grade of C and ECE 513 with min. grade of C

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 with min. grade of C and ECE 513 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 517**Modern Wireless Network Protocols and Standards**

This course introduces cutting-edge wireless networking technologies with focus on the network protocols and standards of the current and next generation wireless networks including cellular networks, wireless local area networks, and wireless ad hoc networks. Specifically, it will cover topics relevant to wireless communications, radio resource management, mobility management, wireless medium access control, wireless routing protocols, and wireless TCP protocols.

Prerequisite(s): ECE 407 with min. grade of C or ECE 408 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 518**Computer Cyber Security**

This course covers 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, wireless network security, email, and web security.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 523**Fundamentals of Semiconductor Devices**

The goals of this course are to give students an understanding of the physical and operational principles behind important electronic devices. Semiconductor electron and hole concentrations, carrier transport, and carrier generation and recombination are discussed. P-N junction operation and its application to diodes, solar cells, and LEDs, are developed. The metal-oxide-semiconductor-field-effect transistor (MOSFET) and bipolar junction transistor (BJT) are then discussed. Applications of transistors in analog and digital circuits are introduced. A term project on a particular device topic is required.

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 with min. grade of C and ECE 312 with min. grade of C

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 with min. grade of C

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 with min. grade of C and ECE 312 with min. grade of C

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, shot, 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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 528**Application Software Design**

The course provides introduction to languages and environments for application software development utilizing Software as a Service (SaaS) for electrical and computer engineers. Languages addressed include Java, Python, SQL, and JavaScript. Key topics covered include systems development life cycle, client-server architectures, database integration, RESTful service, and data visualization. Programming projects will include the development of a data-rich web application with server back-end that connects mobile devices and Internet of Things using Agile software engineering practices. Differential requirement from ECE 448 is a major final project.

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.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 536**Analytical Methods for Power System Economics and Cybersecurity**

Analytical methods for the economic operation of power systems with consideration of transmission losses. Analytical methods for the optimal scheduling of power generation including real power and reactive power. Analytical methods for the estimation of power system state. Analytical methods for the modeling of smart grid cybersecurity. Research project on smart grid cybersecurity.

Prerequisite(s): ECE 319 with min. grade of C or ECE 418 with min. grade of C or ECE 419 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 537**Next Generation Smart Grid**

Paradigm change of power systems; Challenges faced during the paradigm change; Concept of synchronized and democratized (SYNDEM) smart grids; SYNDEM architecture for next-generation smart grids; Technical routes to implement SYNDEM smart grids; Enabling technologies: Three generations of virtual synchronous machines (VSM); Integration of renewables/EV/storage systems through VSM; Integration of flexible loads through VSM; Illinois Tech SYNDEM prototype smart grid.

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 with min. grade of C

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 form queueing networks, approximation techniques for G/G/1 queues and non-product form queueing 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 with min. grade of C

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 with min. grade of C or ECE 408 with min. grade of C

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.

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 with min. grade of C or ECE 408 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 548**Energy Harvesting**

Various harvesting techniques such as solar, ocean tides, 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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 551**Advanced Power Electronics**

Advanced power electronic convertors, techniques to model and control switching circuits, resonant converters, 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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 563**Artificial Intelligence in Smart Grid**

Introduction to artificial intelligence, artificial neural networks, machine learning, and advanced engineering applications in smart grid, including but not limited to energy forecasting, smart meter data analytics, nonintrusive load monitoring.

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 with min. grade of C or ECE 419 with min. grade of C

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**Machine and Deep Learning**

Overview of machine learning and deep learning; principle of learning; Bayesian methods; non-parametric classifiers, Fisher's linear discriminant analysis, principal component analysis; training, validation, and testing; support vector machines; neural networks; history of deep learning; and applications of deep learning.

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 with min. grade of C and MATH 333 with min. grade of C

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 with min. grade of C and ECE 511 with min. grade of C) or ECE 511 with min. grade of C

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 312 with min. grade of C and ECE 307 with min. grade of C) and ECE 403 with min. grade of C

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. Must have successfully passed ECE 307 Electrodynamics or equivalent course.

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 with min. grade of C and ECE 312 with min. grade of C

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 with min. grade of C or ECE 421 with min. grade of C or ECE 423 with min. grade of C

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 with min. grade of C or ECE 423 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 579**Operations and Planning and Distributed Power Grid**

The course is divided into four sub-components: current state of the distributed power grid, outlook for the distributed power grid, operation of the distributed power grid, and planning of the distributed power grid. This course will begin by providing an overview of existing distribution systems and smart grid technologies, such as distribution automation and advanced metering infrastructure (AMI). With the emerging trends in power industry, the course will next focus on trends driving the change and the future components of distributed power grid, including but not limited to distributed generation (DG) and energy storage systems (ESSs). The next part of the course will be focused on the operation and control strategies for distributed power grid systems, including operational constraints, voltage and var control (VVC), and control of DERs and Smart Inverters. The final topic area for the course will be planning of distributed power grid with DERs, including lectures on DER impacts and their assessments, hosting capacity, and microgrid operations.

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 419 with min. grade of C

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 with min. grade of C or ECE 485 with min. grade of C

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 with min. grade of C and ECE 437 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ECE 585**Computer Organization and Design**

This course provides the students with understanding of the fundamental concepts of computer architecture, organization, and design. It focuses on relationship between hardware and software and its influence on the instruction set and the underlying Central Processing Unit (CPU). The structural design of the CPU in terms of datapath and control unit is introduced. The technique of pipelining and hazard management are studied. Advanced topics include instruction level parallelism, memory hierarchy and cache operations, virtual memory, parallel processing, multiprocessors and hardware security. The end to end design of a typical computer system in terms of the major entities including CPU, cache, memory, disk, I/O, and bus with respect to cost/performance trade-offs is also covered. Differentiation between ECE 485 and ECE 585 is provided via use of projects / case studies at differing levels. (3-0-3)

Lecture: 3 Lab: 0 Credits: 3

ECE 586**Hardware Security and Advanced Computer Architectures**

This course focuses on designing computers and embedded computing devices from security and threat-mitigation perspectives. Advanced architecture topics such as instruction level parallelism, multi-threading and multi-instruction, multi-data stream processing are presented. Design for testability, hardware attacks, threat modeling and countermeasures against attacks are covered for the major entities for a computer system; including CPU, memory, and I/O. Case studies on recent examples of hardware security issues are discussed. * Students registering for this course should have a prior knowledge of Computer Organization and Design or equivalent course and be familiar with hardware description languages such as Verilog or VHDL.

Prerequisite(s): ECE 485 or ECE 585 with min. grade of C

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 with min. grade of C and ECE 441 with min. grade of C

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 with min. grade of C

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 590**Object-Oriented Programming and Machine Learning**

This course gives students a clear understanding of the fundamental concepts of object-oriented design/programming (OOD/OOP). Languages addressed include C++ and Python. Key topics covered include introduction to machine and deep learning, software development life cycle, core language and standard library of C++ and Python, class design and design patterns, OpenMP and CUDA platforms. Students will design a complex learning application using these concepts and Agile software engineering practices. Students are required to complete an open-ended project in one of the advanced areas, for example numerical optimization, tool integration, heterogeneous acceleration.

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.**

Corequisite(s): ECE 693

Credit: Variable

ECE 693**Graduate Research Seminar**

Seminar course for graduate students.

Corequisite(s): ECE 691

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 with min. grade of C

Lecture: 2 Lab: 0 Credits: 2

ECE 718**Radio Access Technologies for 5G and Beyond**

The course introduces new radio access network (RAN) technologies and study the theoretical principles underlying the 5G new radio (NR) proposals. The course discusses the fundamentals by which channel coding and new non-orthogonal multiple access (NOMA) techniques improve throughput and reliability; and examine the current research trends and applications with emphasis on the practical implementation of 5G PHYS layer architecture. The main thrust of this course is to study designs that allow multi-user capabilities with interference, bandwidth and energy constraints. Transformations that allow transmission of multiple users and their embedded structures, will be considered. Modulation formats and access techniques that are bandwidth-energy efficient need to be considered. These new designs are studied, generalized and evaluated in different channels and interference conditions. This course has both theoretical and practical goals.

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 with min. grade of C or ECE 408 with min. grade of C) and MATH 477 with min. grade of C

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 with min. grade of C

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**Introduction to Digital Transformation Architecture and Technologies**

This project oriented short course equips the students with the architectural and technological foundation for the upcoming advanced and intelligent applications including smart city, smart energy, smart transportation, and smart health. The digital transformation architecture will be introduced. Key enabling technologies including Internet of Things (IoT), distributed data management and analytics, ubiquitous wireless access, Artificial Intelligence (AI) percepts especially computer vision and machine learning, and cyber security will be highlighted. Leveraging of datasphere which extends across user devices, edge/fog computing, and cloud computing will be addressed. The topics of how various hardware and software constituents interact to provide application solutions will be covered. Specific case studies summarizing the architectures for e-Health and intelligent transportation including autonomous automobile will be discussed.

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 production 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 with min. grade of C

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 420 with min. grade of C and ECE 419 with min. grade of C

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. This course covers fundamental attributes of modern EV and HEV powertrains. Fundamentals of power electronic components (Inverters, DC-DC Converters, and Chargers), electric motors and energy storage systems will be presented in the context of EV powertrains. An introduction to EV/HEV operating strategies, battery chargers and controls will also be discussed. Using a combination of power electronic simulations, finite element analysis, hands-on lab experiments and vehicle benchmarking reports, powertrain configurations of popular EV and HEV powertrain components will be analyzed. State of the art, challenges and future trends will be discussed. Low voltage and high voltage systems and advanced distribution system architectures of electric and hybrid electric vehicles will be included. Current trends in the vehicular industry, such as 48V automotive systems and more electric aircraft, will be explained.

Lecture: 2 Lab: 0 Credits: 2

ENGR 502**Medical Device Regulations and Commercialization**

This course helps prepare students for commercializing medical devices within a highly-regulated environment. Concepts include protecting intellectual property, the structure and scope of the Federal Drug Administration (FDA), developing, testing, producing and marketing medical devices under FDA regulations, total product lifecycle, and quality management.

Lecture: 3 Lab: 0 Credits: 3

ENGR 510**Strategic Engineering Management**

This course will review technology-based enterprises and the driving forces that impact corporate strategy. Students will learn how to apply engineering knowledge to determine technology/product direction and make/buy/partnering decisions. Relationships between research and development, operations, finance, marketing, and other functions within engineering-based organizations that drive strategic decisions will be examined. Strategy development and competitive analysis will be included. Case studies from the industry relevant to the student's engineering track will be reviewed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 520**Best Practices in Engineering Project Management**

Many engineering projects suffer due to weak business cases, schedule slippages, and cost overruns. This course presents commonly used tools and techniques and best practices to build an effective business case, develop a realistic schedule and budget, and successfully execute and complete a project. Students are introduced to a generic project management life cycle model, review basic project management principles, tools, and techniques, and learn engineering-tailored best practices used by high performing, project-centric organizations. Students have an opportunity to apply selected tools in the form of short classroom exercises.

Lecture: 3 Lab: 0 Credits: 3

ENGR 521**Risk Management in Engineering Projects**

In project management, a risk is considered an uncertain event that may have a positive or a negative impact on project objectives. Managing identified threats individually through customized strategies is key to project success. Similarly, opportunities must be leveraged for better project outcomes. Implementation of an effective risk management process is imperative for today's complex projects. This course presents a five-step process to manage project threats as well as opportunities. On every project, students will be able to identify and analyze risks and develop response strategies for each identified risk and take proper response action to manage the risks. Industry best practices and quantitative tools and simulations are used to analyze risk.

Lecture: 3 Lab: 0 Credits: 3

ENGR 531**Urban Systems Engineering Design**

ENGR 531 is a project-based course where students will explore integrated designs of urban systems. Each project will apply the students' engineering disciplines (such as structures, transportation, building science, construction engineering and management, environmental engineering) in a comprehensive analysis that considers the economic, human, and environmental issues associated with the project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 532**Urban Systems Engineering Seminar**

ENGR 532 is an active seminar course that emphasizes current topics in urban systems engineering. Invited speakers will include researchers and representatives from current practice, such as municipal and regional planners and consultants. Appropriate readings will be assigned in advance of each speaker to guide students in preparation for active discussion with each speaker. Each student will also write a term paper on an urban systems engineering topic of their choice, connecting material from the assigned reading, the speakers, and additional references selected by the student.

Lecture: 3 Lab: 0 Credits: 3

ENGR 534**Product Design and Innovation**

This course covers all aspects of planning new products or services that are commercially viable and add to a company's suite of offerings. It includes such topics as user research, market analysis, need/problem identification, creative thinking, ideation, conceptual, competitive benchmarking, human factors, prototyping, evaluation, and testing. The course includes creative, analytical, and technical skills in a balanced approach using such teaching methods as case studies, individual exercises, and group projects.

Lecture: 3 Lab: 0 Credits: 3

ENGR 539**Robotic Motion Planning**

Configuration space. Path planning techniques including potential field functions, roadmaps, cell decomposition, and sampling-based algorithms. Kalman filtering. Probabilistic localization techniques using Bayesian methods. Trajectory planning.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 573**Construction Contract Administration**

Characteristics of the construction industry. Project delivery systems. Duties and liabilities of the parties at the pre-contract stage. Bidding. Contract administration including duties and liabilities of the parties regarding payments, retainage, substantial and final completion, scheduling and time extensions, change orders, changed conditions, suspension of work, contract termination, and resolution of disputes. Contract bonds. Managing the construction company. Labor law and labor relations.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 575**Systems Analysis in 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

ENGR 576**Nano Manufacturing**

This course covers the general methods used for micro- and nano-fabrication and assembly, including photolithography techniques, physical and chemical deposition methods, masking, etching, and bulk micromachining as well as self-assembly techniques. It also covers nanotubes, nanowires, nanoparticles, and the devices that use them, including both electronic and mechanical-electronic systems, as well as nano-structural materials and composites. Focus is on commercially available current processes as well as emerging technologies and evolving research areas. Sensing and instrumentation as well as nano-positioning and actuation are covered briefly.

Lecture: 3 Lab: 0 Credits: 3

ENGR 587**Introduction to Digital Manufacturing**

This course is about the digital revolution taking place in the world of manufacturing and how students, workers, managers, and business owners can benefit from the sweeping technological changes taking place. It is about the change from paper-based processes to digital-based processes all through the design/manufacturing/deliver enterprise, and across the global supply chain. It touches on digital design, digital manufacturing engineering, digital production, digital quality assurance, and digital contracting, from large companies to small. There is also a significant focus on cyber security and the new types of threats that manufacturers face in the new digital world. Other topics covered include intelligent machines, connectivity, the digital thread, big data, and the Industrial Internet of Things (IIoT).

Lecture: 3 Lab: 0 Credits: 3

ENGR 588**Additive Manufacturing**

This course examines the fundamentals of a variety of additive manufacturing processes as well as design for additive manufacturing, materials available, and properties and limitations of materials and designs. It also examines the economics of additive manufacturing as compared to traditional subtractive manufacturing and other traditional techniques. Additive techniques discussed include 3D printing, selective laser sintering, stereo lithography, multi-jet modeling, laminated object manufacturing, and others. Advantages and limitations of all current additive technologies are examined as well as criteria for process selection. Processes for metals, polymers, and ceramics are covered. Other topics include software tools and connections between design and production, direct tooling, and direct manufacturing. Current research trends are discussed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 592**Engineering Management Capstone Experience**

Students apply the knowledge they have acquired in the Engineering Management program to a specific problem or case study. Projects will be identified and mentored in conjunction with faculty and industrial partners. A final report or business plan is required that reflects the focus of the capstone project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 595**Product Development for Entrepreneurs**

Elements of product development (mechanical and electrical), manufacturing and production planning, supply chain, marketing, product research, and entrepreneurship concepts are taught in this class. In this course, student teams will be required to create a compelling product that has potential to be sold in today's marketplace. They will be required to create functional prototypes of their product for people to use and critique. If successful, students will be allowed to put their product on Kickstarter.com and take orders for delivery after the class is complete while potentially fostering their own business as a result of this course.

Lecture: 3 Lab: 0 Credits: 3

ENGR 596**Practical Engineering Training**

This course is a mentored, immersive practical engineering training. Students learn under the direction of professional engineers and practicing engineers by working on real engineering projects. The student will perform hands-on engineering, including learning and developing/applying engineering principles and concepts to complete the project assigned to the student. The student will apply engineering ethics and safety during their practical engineering training. Students will communicate the results of their work in written and oral communications. Students will receive assignments of varying complexity consistent with their graduate standing.

Lecture: 0 Lab: 9 Credits: 3

ENGR 598**Graduate Research Immersion: Team Project**

This course provides a faculty-mentored immersive team-based research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

ENGR 599**Graduate Research Immersion: Individual**

This course provides a faculty-mentored immersive research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

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 Department of Electrical and Computer Engineering. 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

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

Code	Title	Credit Hours
Required Core Courses		(12)
ECE 481	Image Processing	3
or ECE 565	Compt Vision Image Processing	
ECE 437	Digital Signal Processing I	3
or ECE 569	Digital Signal Processing II	
ECE 511	Analysis Random Signals	3
Select a minimum of one course from the following:		3
BIOL 430	Human Physiology	3
BME 450	Animal Physiology	3
BME 453/553	Quantitative Physiology	3
Imaging Elective Courses		(3)
Select a minimum of one course from the following:		3
BME 537	Intro to Molecular Imaging	3
BME 538	Neuroimaging	3
BME 597	Special Problems	3

ECE 597	Special Problems	3
Signals Elective Courses		(6)
Select a minimum of two courses from the following:		6
ECE 505	Applied Optimization Engrgs	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 568	Digital Speech Processing	3
ECE 597	Special Problems	3
BME 597	Special Problems	3
General Electives		(9)
Select nine 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 Computational Engineering, Optimization, Machine Vision, and Decision Making Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
Select nine credit hours from the following courses:		9
BME 522	Math Methods in BME	3
BME 553	Quantitative Physiology	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 536	Computational Techniques Engg	3
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Optimization, Machine Vision, and Decision Making Courses		(12)
Select 12 credit hours from the following courses:		12
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 597	Special Problems	1-6
Elective Courses		(9)
Select nine credit hours from the following courses: ¹		9
BME 445	Quantitative Neural Function	3
BME 522	Math Methods in BME	3
BME 523	Cell Biomechanics	3
BME 524	Quant Aspects Cell/Tissue Engg	3
BME 525	Introduction to Medical Device	3
BME 538	Neuroimaging	3
BME 553	Quantitative Physiology	3
BME 597	Special Problems	1-6

CAE 530	Finite Element Method of Anlys	3
CAE 534	Computational Techniques	3
CAE 535	Nonlinear Finite Element Anlys	3
CAE 597	Special Problems	1-6
CHE 536	Computational Techniques Engg	3
CHE 439	Numerical Data Analysis	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 516/BME 517	Tech for Treatment of Diabetes	3
CHE 535	Applctn Math Cheml Engrg	3
CHE 536	Computational Techniques Engg	3
CHE 560	Ststcl Qlty Process Control	3
CHE 585	Drug Delivery	3
CHE 597	Special Problems	1-6
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 597	Special Problems	1-6
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 450	Computational Mechanics II	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 518	Spec Methods Comp Fluid Dynmcs	3
MMAE 532	Finite Element Methods II	3
MMAE 570	Computational Methods in MSE	3
MMAE 594	Proj for Master of Engg Stud	1-6
MMAE 597	Special Topics	1-6

Total Credit Hours

30

¹ Course must not have been used towards the core course or specialization course requirements.

Master of Computer Engineering in Internet of Things

The objective of IoT is to enhance both device-to-device interactions, as well as device-to-human interactions via the Internet. IoT systems facilitate controlling and monitoring devices from anywhere by integrating sensors, actuators, local processing and storage devices, wireless networks, Internet, and cloud computing. IoT engineers also need to understand the Cyber Security and Big Data challenges for IoT applications. Learning every major aspect of these technologies is necessary to be a successful engineer in the field of Internet of Things. Students will be trained to master several key topics in the field of computer networking, embedded systems, system architectural design issues, communication and information systems, smart grids and cybersecurity.

Requirement	Credits
Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level+ Credit	18
Maximum 700-Level Credit	4

Code	Title	Credit Hours
Required Courses		(16)
ECE 441	Microcomputers/Embedded Comp	4
ECE 442	Internet of Things/Cyber Phys	3
ECE 518	Computer Cyber Security	3
ECE 545	Advanced Computer Networks	3
ECE 587	Hardware Software Codesign	3
Network Engineering Elective		(3)
Select three credit hours from the following:		3
ECE 504	Wireless Comm Systm Design	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
Computer Engineering Elective		(3)
Select three credit hours from the following:		3
CS 480	Introduction to Artificial Int	3
CS 584	Machine Learning	3
ECE 449	Obj-Oriented Cmptr Sim	3
ECE 528	Application Software Design	3
ECE 585	Computer Org and Design	3
ECE 597	Special Problems (Internet of Things)	1-3
Signal and Image Processing Elective		(3)
Select three credit hours from the following:		3
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 508	Video Processing & Comm	3
ECE 511	Analysis Random Signals	3
ECE 535	Discrete Time Systems	3
ECE 553	Power System Planning	3
ECE 563	AI in Smart Grid	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Machine and Deep Learning	3
ECE 567	Statistical Signal Processing	3
ECE 569	Digital Signal Processing II	3
Electives		(5)
Select five credit hours from any of the Network Engineering, Computer Engineering, or Signal and Image Processing electives. Electives may also be chosen from the following courses:		5
ECE 505	Applied Optimization Engrgs	3
ECE 512	Hybrid Electric Vehicle Drives	3
ECE 537	Next Generation Smart Grid	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 581	Elements of Smart Grid	3

ECE 582	Microgrid Design and Operation	3
Total Credit Hours		30

- ¹ Courses may be chosen from the Network Engineering, Computer Engineering, or Signal and Image Processing elective options, provided that those courses were not already used to satisfy another degree requirement.

Master of Cyber Security Engineering

Rapid growth in the reliance of critical and personal information on cyber infrastructure has made us more vulnerable to cyber threats and cyberattacks. This master's program will educate students with techniques, tools, analysis, policies, and methodologies to solve complex cyber security problems of relevance to the engineering field.

There is a strong demand for security professionals in industries with the increase in cyber threats to their systems. This program will prepare students with extensive knowledge in cyber security, cyber-physical systems, cloud computing security, network engineering and cyber security for smart grid power systems, security vision systems, coding theory, and wireless secure communications.

Admission to the Master of Cyber Security Engineering program normally requires a bachelor of science degree in electrical or computer engineering from an institution accredited by the Accreditation Board of Engineering and Technology (ABET). Deficiency courses will be required for students who have not taken prerequisite or equivalent courses of the following: ECE 242 and MATH 374. 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.

Requirement	Credits
Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level Credit	18
Maximum 700-Level Credit	4

Code	Title	Credit Hours
Required Courses		(15-16)
ECE 518	Computer Cyber Security	3
ECE 543	Computer Network Security	3
Select 9-10 credit hours from the following:		9-10
ECE 407 or ECE 408	Intro Comp Ntwks with Lab Intro to Computer Ntwks	3-4
ECE 442	Internet of Things/Cyber Phys	3
ECE 520	Info Theory and Applications	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 545	Advanced Computer Networks	3
ECE 546	Wireless Network Security	3
Cyber Security Legal and Regulatory Classes		(2-6)
Select two to six credit hours from the following:		2-6
ITMS 538	Cyber Forensics	3
ITMS 578	Cyber Security Mgmt	3
ITMS 584	Governance, Risk, & Compliance	3
LAW 215	E Commerce	2,3
LAW 252	Law of Privacy	3
LAW 285	Cyber Fraud-Priv Class Actions	2
LAW 295	Data Privacy and Security	2
LAW 478	Computer & Network Privacy	3
LAW 907	Law of Social Networks	2
LAW 926	Freedom of the Internet	2
Electrical and Computer Engineering Electives		(8-13)
Select 8-13 credit hours from the following:		8-13
ECE 403	Digital & Data Comm Systems	3
ECE 406	Intro to Wireless Comm Systems	3

ECE 420	Analyt. Methods for Power Syst	3
ECE 437	Digital Signal Processing I	3
ECE 441	Microcomputers/Embedded Comp	4
ECE 446	Advanced Logic Design	4
ECE 449	Obj-Oriented Cmptr Sim	3
ECE 485	Computer Organization & Design	3
ECE 504	Wireless Comm System Design	3
ECE 508	Video Processing & Comm	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Enrgy Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 519	Coding Reliable Communications	3
ECE 542	Dsgn Optmztn Compt Ntwrks	3
ECE 544	Wireless and Mobile Networks	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 569	Digital Signal Processing II	3
ECE 570	Fiber Optic Communication Syst	3
ECE 597	Special Problems	3

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.

Requirement	Credits
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

Code	Title	Credit Hours
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

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

Code	Title	Credit Hours
Required Core Courses		(15)
Select a minimum of five courses from the following:		15
ECE 417	Power Dist Engring	3
ECE 418	Power Systems Analysis	3
ECE 420	Analyt. Methods for Power Syst	3
ECE 537	Next Generation Smart Grid	3
ECE 553	Power System Planning	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 579	Oper/Plan/Dist Power Grid	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 Analys in Fin Mkts ¹	3
MSF 503	Financial Modeling ¹	3
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/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 & Equity Deriv Trading	3
General Electives		(9)
Select nine 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.CPE. 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 six credit hours of adviser-approved elective courses. At least 18 credit hours of the courses must be at the 500-level. A maximum of six credit hours may be taken from ECE 700-level short courses.

Curriculum

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

Code	Title	Credit Hours
Required Courses		(12-13)
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 541	Perform Eval Compt Ntwrk	3

or ECE 542	Dsgn Optmztn Compt Ntwrks		
Select a minimum of one course from the following:			3-4
ECE 407	Intro Comp Ntwks with Lab	4	
or ECE 408	Intro to Computer Ntwks		
ECE 545	Advanced Computer Networks	3	
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 & Data Comm Systems	3	
or ECE 405	Digital & Data Comm Syst w/Lab		
ECE 406	Intro to Wireless Comm Systems	3	
ECE 436	Digital Signal Pcsgr w/Lab	4	
ECE 437	Digital Signal Processing I	3	
ECE 442	Internet of Things/Cyber Phys	3	
ECE 443	Intro Computer Cyber Security	3	
ECE 485	Computer Organization & Design	3	
ECE 504	Wireless Comm Systm Design	3	
ECE 508	Video Processing & Comm	3	
ECE 514	Digital Commctn Principles	3	
ECE 515	Modern Digital Communications	3	
ECE 516	Coding Distributed Storage Sys	3	
ECE 517	Wireless Ntwrk Protocols/Stand	3	
ECE 518	Computer Cyber Security	3	
ECE 519	Coding Reliable Communications	3	
ECE 520	Info Theory and Applications	3	
ECE 541	Perform Eval Compt Ntwrk	3	
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3	
ECE 565	Compt Vision Image Processing	3	
ECE 568	Digital Speech Processing	3	
ECE 569	Digital Signal Processing II	3	
ECE 570	Fiber Optic Communication Syst	3	
ECE 583	High Speed Compt Arithmetic	3	
ECE 584	VLSI Archs Sgnl Prcs Commcnctns	3	
ECE 585	Advanced Compt Arch	3	
CS 455	Data Communication	3	
CS 548	High-Speed Networks	3	
Electives			(6)
Select six credit hours			6

¹ A maximum of six 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

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

Code	Title	Credit Hours
Core Courses		(12-14)
ECE 418 or ECE 419	Power Systems Analysis Power Systems Analysis w/Lab	3-4
Select a minimum of three courses from the following:		9-10
ECE 411	Power Electronics	4
ECE 420	Analyt. Methods for Power Syst (For Undergraduate only)	3
ECE 512	Hybrid Electric Vehicle Drives	3
ECE 537	Next Generation Smart Grid	3
ECE 551	Advanced Power Electronics	3
Power Systems		(6)
Select a minimum of two courses from the following:		6
ECE 417	Power Dist Engring	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intllgnc Engineering	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 579	Oper/Plan/Dist Power Grid	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 Envir 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	Cmpt Aided Dsgn Elec Machines	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 552	Adjustable Speed Drives	3
ECE 764	Vehicular Power Systems	2
CHE 541	Renwble Enrgy Technologies	3
General Electives		(4-6)
Select four to six credit hours		4-6

Up to three credit hours of a Graduate Special Project in power engineering (ECE 594 or ECE 597), and up to six 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 is offered by the Department of Electrical and Computer Engineering (ECE) and 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.CPE., 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.

Curriculum

Master of Telecommunications and Software Engineering, Computer Engineering Concentration

Requirement	Credits
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

Code	Title	Credit Hours
Required Courses		(15-16)
ECE 513	Commctn Enrg Fundamentals	3
CS 586	Software Systems Arch	3

CS 587	Software Project Management	3
ECE 541	Perform Eval Compt Ntwrk	3
or ECE 542	Dsgn Optmztn Compt Ntwrks	
Select a minimum of one course from the following:		3-4
ECE 407	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 545	Advanced Computer Networks	3
Software Engineering		(3)
Select a minimum of one course from the following:		3
CS 521	Object-Oriented Analysis/Dsgn	3
CS 537	Software Metric	3
CS 589	Software Testing and Anlys	3
ECE 449	Obj-Orntd Cmptr Sim	3
Telecommunication Systems		(3-4)
Select a minimum of one course from the following:		3-4
CS 544	Computer Ntwrks II: Ntwrk Svc	3
CS 548	High-Speed Networks	3
CS 555	Anlytc Mdls Simul Comp Syst	3
ECE 443	Intro Computer Cyber Security	4
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Ntwrks Perf Analysis	3
Communications		(3)
Select a minimum of one course from the following:		3
ECE 504	Wireless Comm Systm Design	3
ECE 508	Video Processing & Comm	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 519	Coding 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:

Code	Title	Credit Hours
CS 588	Advnd Software Engrg Dev	3
ECE 436	Digital Signal Pcsgr w/Lab	4
ECE 437	Digital Signal Processing I	3
ECE 511	Analysis Random Signals	3
ECE 516	Coding Distributed Storage Sys	3
ECE 520	Info Theory and Applications	3
ECE 565	Compt Vision Image Processing	3
ECE 568	Digital Speech Processing	3
ECE 569	Digital Signal Processing II	3
ECE 584	VLSI Archs Sgnl Prcs Commctns	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

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

Code	Title	Credit Hours
Core Courses		(16)
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 523	Fund of Semiconductor Devices	3
ECE 525	RF Integrated Circuit Design	3
ECE 529	Advncd VLSI Systems Dsgn	3
Computer Engineering		(3)
Select a minimum of one course from the following:		3
ECE 485	Computer Organization & Design	3
ECE 518	Computer Cyber Security	3
ECE 528	Application Software Design	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 542	Dsgn Optmztn Compt Ntwrks	3
ECE 545	Advanced Computer Networks	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commcnctns	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Detcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	3
Electronics		(3)
Select a minimum of one course from the following:		3
ECE 401	Communication Electronics	3
ECE 425	Anlys Dsgn Intgrtd Circuits	3

ECE 521	Quantum Electronics	3
ECE 524	Adv Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Perform Anlys RF Intgrtd Crcts	3
ECE 551	Advanced Power Electronics	3
ECE 570	Fiber Optic Communication Syst	3
ECE 571	Nanodevices Technology	3
ECE 575	Electron Devices	3
ECE 578	Microwave Theory	3

General Electives	(8)
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Select eight credit hours of electives from ECE 400-799 ¹	8
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Total Credit Hours	30
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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 Engineering in Advanced Manufacturing, Automation and Control Systems Track

Curriculum

Code	Title	Credit Hours
Core Courses		(12-14)
Select 12-14 credit hours from the following courses:		12-14
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
MMAE/ENGR 534	Product Design and Innovation	3
MMAE 544	Design Optimization	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 547	Comp Intgrtd Manuf Technlgies	3
MMAE 557	Comp Intgrtd Manfctrng Sysms	3
MMAE 560	Ststcl Quality Procs Control	3
Automation and Control Systems Courses		(9-10)
Select 9-10 credit hours from the following courses:		9-10
ECE 437	Digital Signal Processing I	3
ECE 441	Microcomputers/Embedded Comp	4
ECE 481	Image Processing	3
ECE 533	Robust Control	3
ECE 539	Compt Aided Dsgn Elec Machines	3
ECE 540	Relibilty Theory Syst Implntn	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dymcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 565	Compt Vision Image Processing	3
Elective Courses		(6-9)
Select six to nine credit hours from the below courses:		6-9
ECE 594	Special Projects	1-9
or MMAE 594	Proj for Master of Engg Stud	
ENGR 595	Product Development	3

MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 532	Finite Element Methods II	3
MMAE 570	Computational Methods in MSE	3

Minimum degree credits required: 30

Master of Engineering in Artificial Intelligence for Computer Vision and Control

AI has become a valuable and important catalyst for other technologies such as the Internet of Things and Cyber Physical Systems. AI is also considered as the engine that powers several truly ground-breaking Computer Vision, Control and Cybernetic applications such as autonomous cars, robotic personal assistants and automated manufacturing. The Master of Engineering in Artificial Intelligence, Computer Vision and Control degree is intended to provide interested students maximum exposure towards the very fast evolving AI technologies, machine learning, and methods while particularly targeting Electrical and Computer Engineering topics such as computer vision, medical image diagnosis, power system distribution, robotics and automation. Today, all major new technology products inherit a layer of artificial intelligence unit for self-learning and adaptability. Depending on the application or platform, this AI component can be used for speech recognition, face recognition or context-aware human-device interactions. The wide use of these AI technologies resulted in a major spike in the demand for engineers who are trained in this dynamic and fast-growing exciting field. Through the Master of Engineering in Artificial Intelligence, Computer Vision and Control students will be ready to overcome challenges in the field of core AI framework, signal & image processing and computer vision, control systems, embedded systems, integrated circuits and VLSI including neuromorphic computing, network, communication and information systems, power systems and robotics.

Requirement	Credits
Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level+ Credit	18
Maximum 700-Level Credit	4

Code	Title	Credit Hours
Required Courses		(15-16)
Select 15-16 credit hours from the following:		15-16
CS 480 or CS 584	Introduction to Artificial Int Machine Learning	3
ECE 437 or ECE 569	Digital Signal Processing I Digital Signal Processing II	3
ECE 441 or ECE 442	Microcomputers/Embedded Comp Internet of Things/Cyber Phys	3-4
ECE 481 or ECE 565	Image Processing Compt Vision Image Processing	3
ECE 438 or ECE 533	Control Systems Robust Control	3
ECE 563 or ECE 566	AI in Smart Grid Machine and Deep Learning	3
Signal and Image Processing Elective		(3)
Select a minimum of three credit hours from the following:		3
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 508	Video Processing & Comm	3
ECE 511	Analysis Random Signals	3
ECE 535	Discrete Time Systems	3
ECE 563	AI in Smart Grid	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Machine and Deep Learning	3
ECE 567	Statistical Signal Processing	3
ECE 569	Digital Signal Processing II	3

Computer Engineering Elective**(3)**

Select a minimum of three credit hours from the following:

3

CS 480	Introduction to Artificial Int	3
CS 584	Machine Learning	3
ECE 441	Microcomputers/Embedded Comp	4
ECE 442	Internet of Things/Cyber Phys	3
ECE 449	Obj-Oriented Cmptr Sim	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 518	Computer Cyber Security	3
ECE 520	Info Theory and Applications	3
ECE 528	Application Software Design	3
ECE 545	Advanced Computer Networks	3
ECE 585	Computer Org and Design	3
ECE 587	Hardware Software Codesign	3
ECE 597	Special Problems	1-3

Power and Control Engineering Elective**(3)**

Select a minimum of three credit hours from the following:

3

ECE 411	Power Electronics	4
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 512	Hybrid Electric Vehicle Drives	3
ECE 533	Robust Control	3
ECE 537	Next Generation Smart Grid	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 555	Power Market Operations	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 560	Power Syst Dynamics Stability	3
ECE 563	AI in Smart Grid	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 579	Oper/Plan/Dist Power Grid	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3

Elective Courses**(5-6)**Select five to six credit hours ¹

5-6

¹ The remaining elective courses may be chosen from any of the listed core or elective options, provided that those courses were not already used to satisfy another degree requirement.

Master of Engineering in Energy Systems, Energy Transmission and Markets Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
CHE 543	Energy Envir Economics	3
ECE 418	Power Systems Analysis	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
Energy Transmission and Markets Courses		(12-14)
Select 12-14 credit hours from the following courses:		12-14
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 551	Advanced Power Electronics	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 597	Special Problems	1-3
Elective Courses		(7-9)
Select seven to nine credit hours from the following courses: ¹		7-9
CAE 513	Building Science	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CHE 541	Renwble Enrgy Technologies	3
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3
ECE 597	Special Problems	1-3
MMAE 425	Direct Energy Conversion	3
MMAE 433	Design of Thermal Systems	3
MMAE 453	Adv Automotive Powertrains	3
MMAE 523	Fundamentals Power Generation	3
MMAE 525	Fundamentals of Heat Transfer	3

Minimum degree credits required: 30

¹ Course must not have been used to fulfill specialization course requirement.

Master of Engineering in Wireless Communications and Computer Networks

Wireless communications and computer networks are a rapid-growing field which requires state-of-the-art engineering skills including wireless network protocols and standards, energy-efficient networking, modeling and performance analysis of distributed and mobile network computing, and cognitive radio networks. In this program, students will be exposed to the core of network communications, gain latest applied computer network techniques including data security and privacy, ability to design embedded system architecture for wireless communication systems and applications, and fundamentals of wireless radio communications and signal analysis.

Requirement	Credits
Minimum Credits Required	30
Maximum 400-Level Credit	12
Minimum 500-Level+ Credit	18
Maximum 700-Level Credit	4

Code	Title	Credit Hours
Required Courses		(9-10)
ECE 401 or ECE 525	Communication Electronics RF Integrated Circuit Design	3
ECE 403 or ECE 405 or ECE 513	Digital & Data Comm Systems Digital & Data Comm Syst w/Lab Commctn Engrg Fundamentals	3-4
ECE 517 or ECE 544	Wireless Ntwrk Protocols/Stand Wireless and Mobile Networks	3
Communication Elective		(3-4)
Select one course from the following:		3-4
ECE 406	Intro to Wireless Comm Systems	3
ECE 421 or ECE 423	Microwave Circuits and Systems Microwave Crct&Systs w/Lab	3-4
ECE 504	Wireless Comm Systm Design	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
Computer Networks Elective		(3-4)
Select one course from the following:		3-4
ECE 407 or ECE 408	Intro Comp Ntwks with Lab Intro to Computer Ntwks	3-4
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 543	Computer Network Security	3
ECE 544	Wireless and Mobile Networks	3
ECE 545	Advanced Computer Networks	3
Communication Electronics Elective		(3-4)
Select one course from the following:		3-4
ECE 401	Communication Electronics	3
ECE 412 or ECE 423	Hybrid Electric Vehicle Drives Microwave Crct&Systs w/Lab	4
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 525	RF Integrated Circuit Design	3

ECE 570	Fiber Optic Communication Syst	3
ECE 576	Antenna Theory	3
ECE 578	Microwave Theory	3
ECE 589	CAD of Analog IC	3
Computer and Embedded Computing Elective		(3-4)
Select one course from the following:		3-4
ECE 441	Microcomputers/Embedded Comp	4
ECE 442	Internet of Things/Cyber Phys	3
ECE 518	Computer Cyber Security	3
ECE 528	Application Software Design	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
ECE 585	Computer Org and Design	3
ECE 586	Hardwr Security & Adv Comp Arc	3
ECE 587	Hardware Software Codesign	3
ECE 590	Object-Oriented Program & ML	3
Elective Courses		(4-9)
Select four to nine credit hours ¹		4-9

¹ The remaining elective courses may be chosen from any of the listed core or elective options, provided that those courses were not already used to satisfy another degree requirement.

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.CPE.) 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.CPE., 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 six 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 each of the two remaining areas. An M.S.CPE. candidate may, with permission of a thesis adviser, include in their program a thesis of six to eight 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)

Requirement	Credits
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

Code	Title	Credit Hours
Computer Engineering Major Courses		(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 159)		6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 159)		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. 159)		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)

Requirement	Credits
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

Code	Title	Credit Hours
Computer Engineer Major Courses		(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 159)		6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 159)		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. 159)		6-8
General Electives		(1-8)
Select one to eight credit hours of general ECE electives		1-8
Thesis Research		(6-8)
ECE 591	Research and Thesis M.S. ¹	6-8

¹ Students pursuing the thesis option must complete six to eight 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

Code	Title	Credit Hours
Core Courses		(6-7)
ECE 529 or ECE 429	Advncd VLSI Systems Dsgn Intro to VLSI Design	3-4
ECE 585	Advanced Compt Arch	3
Elective Courses		(51)
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 441	Microcomputers/Embedded Comp	4
ECE 442	Internet of Things/Cyber Phys	3

ECE 446	Advanced Logic Design	4
ECE 485	Computer Organization & Design	3
ECE 523	Fund of Semiconductor Devices	3
ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Detcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	3

Computer Systems Software

Code	Title	Credit Hours
Core Courses		(6)
CS 550	Advanced Operating Systems	3
CS 551	Operating Syst Design&Implemtn	3
Elective Courses		(39)
ECE 449	Obj-Orrtd Cmptr Sim	3
ECE 518	Computer Cyber Security	3
ECE 587	Hardware Software Codesign	3
CS 487	Software Engineering	3
CS 545	Distributed Computing Lndscp	3
CS 546	Parallel and Distributed Proc	3
CS 550	Advanced Operating Systems	3
CS 551	Operating Syst Design&Implemtn	3
CS 555	Anlytc Mdls Simul Comp Syst	3
CS 586	Software Systems Arch	3
CS 587	Software Project Management	3
CS 588	Advnd Software Engrg Dev	3
CS 589	Software Testing and Anlys	3

Networks and Telecommunications

Code	Title	Credit Hours
Core Courses		(7)
ECE 407	Intro Comp Ntwks with Lab	4
or ECE 408	Intro to Computer Ntwks	
ECE 541	Perform Eval Compt Ntwrk	3
or ECE 545	Advanced Computer Networks	
Elective Courses		(70)
ECE 407	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 504	Wireless Comm Systm Design	3
ECE 508	Video Processing & Comm	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3

ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
ECE 570	Fiber Optic Communication Syst	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
CS 455	Data Communication	3
CS 544	Computer Ntwrks II: Ntwrk Svc	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.CPE/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.CPE./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.CPE./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.CPE./E.E. degree requirements are described in the section below. Requirements for the M.S.CPE./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.CPE./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 CPE./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 or CS 350	Digital Computers and Computing Computer Organization and Assembly Language Programming	3
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.CPE./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

- d. A minimum of two courses chosen from either or both of the remaining EE areas of concentration
 - 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 six credit hours of ECE short courses; six to eight 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 their formal letter of admission to the master's program.

Master of Science in Computer Engineering and Electrical Engineering (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	45
Minimum 500-Level Credit	30
Minimum ECE Credit	30
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Computer Engineering Major Courses		(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 163)		6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 163)		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. 163)		6-8
Electrical Engineering Major Courses		(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 165)		12-16
Electrical Engineering Minor Electives		(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 165)		6-8
General Electives		(0-9)
Select zero to nine credit hours of general ECE electives		0-9

Master of Science in Computer Engineering and Electrical Engineering (Thesis Option)

Requirement	Credits
Minimum Credits Required	45
Minimum 500-Level Credit	30
Minimum ECE Credit	30
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Computer Engineering Major Courses		(12-15)
Select two core courses from the chosen CPE area of concentration from the lists below (p. 163)		6-7
Select two elective courses from the chosen CPE area of concentration from the lists below (p. 163)		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. 163)		6-8
Electrical Engineering Major Courses		(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 165)		12-16
Electrical Engineering Minor Electives		(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 165)		6-8
General Electives		(0-3)
Select zero to three credit hours of general ECE electives		0-3
Thesis Research		(6-8)
ECE 591	Research and Thesis M.S.	6-8

¹ Students pursuing the thesis option must complete six to eight 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

Code	Title	Credit Hours
Core Courses		(6-7)
ECE 529 or ECE 429	Advncd VLSI Systems Dsgn Intro to VLSI Design	3-4
ECE 585	Advanced Compt Arch	3
Elective Courses		(48)
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 430	Fund of Semiconductor Devices	3
ECE 441	Microcomputers/Embedded Comp	4
ECE 446	Advanced Logic Design	4
ECE 485	Computer Organization & Design	3
ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Detcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	3

Computer Systems Software

Code	Title	Credit Hours
Core Courses		(6)
CS 550	Advanced Operating Systems	3
CS 551	Operating Syst Design&Implemtn	3
Elective Courses		(36)
ECE 449	Obj-Orntd Cmptr Sim	3
ECE 587	Hardware Software Codesign	3
CS 487	Software Engineering	3
CS 545	Distributed Computing Lndscp	3
CS 546	Parallel and Distributed Proc	3
CS 550	Advanced Operating Systems	3
CS 551	Operating Syst Design&Implemtn	3
CS 555	Anlytc Mdls Simul Comp Syst	3
CS 586	Software Systems Arch	3
CS 587	Software Project Management	3
CS 588	Advnd Software Engrg Dev	3
CS 589	Software Testing and Anlys	3

Networks and Telecommunications

Code	Title	Credit Hours
Core Courses		(7)
ECE 407 or ECE 408	Intro Comp Ntwks with Lab Intro to Computer Ntwks	4
ECE 541 or ECE 545	Perform Eval Compt Ntwrk Advanced Computer Networks	3
Elective Courses		(74)
ECE 407	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 443	Intro Computer Cyber Security	4
ECE 504	Wireless Comm Systm Design	3
ECE 508	Video Processing & Comm	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
ECE 570	Fiber Optic Communication Syst	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
CS 455	Data Communication	3
CS 544	Computer Ntwrks II: Ntwrk Svc	3

EE Areas of Concentration

Communications and Signal Processing

Code	Title	Credit Hours
ECE 401	Communication Electronics	3
ECE 403	Digital & Data Comm Systems	3
ECE 405	Digital & Data Comm Syst w/Lab	4
ECE 406	Intro to Wireless Comm Systems	3
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Crct&Systs w/Lab	4
ECE 436	Digital Signal Pcsgr w/Lab	4
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 504	Wireless Comm Systm Design	3
ECE 507	Imaging Theory & Applications	3
ECE 508	Video Processing & Comm	3
ECE 509	Electromagnetic Field Theory	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
ECE 522	Electromagnetic Compatibility	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	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 Syst	3
ECE 576	Antenna Theory	3
ECE 578	Microwave Theory	3

Computers and Microelectronics

Code	Title	Credit Hours
ECE 407	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 430	Fund of Semiconductor Devices	3
ECE 441	Microcomputers/Embedded Comp	4
ECE 443	Intro Computer Cyber Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Obj-Orrtd Cmptr Sim	3
ECE 485	Computer Organization & Design	3
ECE 502	Basic Network Theory	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 521	Quantum Electronics	3
ECE 524	Adv Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Perform Anlys RF Intgrtd Crcts	3

ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
ECE 571	Nanodevices Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Detcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	3

Power and Control

Code	Title	Credit Hours
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 417	Power Dist Engring	3
ECE 418	Power Systems Analysis	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 506	Anlys 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	Compt Aided Dsgn Elec Machines	3
ECE 540	Relibty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dymcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgnce Engineering	3

ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 579	Oper/Plan/Dist Power Grid	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 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 six 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 their program a thesis of six to eight 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)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level ECE Credit	20
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Code	Title	Credit Hours
Electrical Engineering Major Courses		(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 168)		12-16
Electrical Engineering Minor Electives		(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 168)		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)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Minimum 500-Level ECE Credit	20
Maximum 700-Level Credit	6
Maximum Transfer Credit	9

Code	Title	Credit Hours
Electrical Engineering Major Courses		(12-16)
Select four courses from the chosen EE area of concentration from the lists below (p. 168)		12-16
Electrical Engineering Minor Electives		(6-8)
Select two courses from either or both of the remaining EE areas of concentration (p. 168)		6-8
General Electives		(0-8)
Select zero to eight credit hours of general ECE electives		0-8
Thesis Research		(6-8)
ECE 591	Research and Thesis M.S. ¹	6-8

¹ Students pursuing the thesis option must complete six to eight 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

Code	Title	Credit Hours
ECE 401	Communication Electronics	3
ECE 403	Digital & Data Comm Systems	3
ECE 405	Digital & Data Comm Syst w/Lab	4
ECE 406	Intro to Wireless Comm Systems	3
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Crct&Systs w/Lab	4
ECE 436	Digital Signal Pcsgr w/Lab	4
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 504	Wireless Comm Systm Design	3
ECE 507	Imaging Theory & Applications	3
ECE 508	Video Processing & Comm	3
ECE 509	Electromagnetic Field Theory	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
ECE 522	Electromagnetic Compatibility	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	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 Syst	3

ECE 576	Antenna Theory	3
ECE 578	Microwave Theory	3

Computers and Microelectronics

Code	Title	Credit Hours
ECE 407	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 441	Microcomputers/Embedded Comp	4
ECE 443	Intro Computer Cyber Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Obj-Orntd Cmptr Sim	3
ECE 485	Computer Organization & Design	3
ECE 502	Basic Network Theory	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 518	Computer Cyber Security	3
ECE 521	Quantum Electronics	3
ECE 523	Fund of Semiconductor Devices	3
ECE 524	Adv Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Perform Anlys RF Intgrtd Crcts	3
ECE 528	Application Software Design	3
ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
ECE 571	Nanodevices Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Detcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	3

Power and Control

Code	Title	Credit Hours
ECE 411	Power Electronics	4
ECE 417	Power Dist Engring	3
ECE 418	Power Systems Analysis	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 506	Anlys Nonlinear Systems	3

ECE 512	Hybrid Electric Vehicle Drives	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	Cmpt Aided Dsgn Elec Machines	3
ECE 540	Relibilty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 579	Oper/Plan/Dist Power Grid	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 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. 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

Requirement		Credits
Minimum Degree Credits		72
Maximum 400-Level Credit		12
Minimum 500-Level Credit		15
Maximum 700-Level Credit		6
Maximum Transfer Credit		36

Code	Title	Credit Hours
Ph.D. Research		(24-25)
ECE 691	Research and Thesis Ph.D.	24-25
Transfer Coursework		(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

Requirement	Credits
Minimum Degree Credits	72
Maximum 400-Level Credit	12
Minimum 500-Level Credit	15
Maximum 700-Level Credit	6
Maximum Transfer Credit	36

Code	Title	Credit Hours
Ph.D. Research		(24-25)
ECE 691	Research and Thesis Ph.D.	24-25
Transfer Coursework		(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 Envir 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	Hybrid Electric Vehicle Drives	4
ECE 417	Power Dist Engring	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 506	Anlys Nonlinear Systems	3
ECE 531	Linear System Theory	3
ECE 535	Discrete Time Systems	3
ECE 538	Renewable Energies	3
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 540	Relibilty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 564	Cntrl Oprtn Elect Power Systs	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 three to six 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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 Envir 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	Hybrid Electric Vehicle Drives	4
ECE 417	Power Dist Engring	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 506	Anlys 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	Cmpt Aided Dsgn Elec Machines	3
ECE 540	Relibty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 564	Cntrl Oprtn Elect Power Systs	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 & Data Comm Systems	3
ECE 405	Digital & Data Comm Syst w/Lab	4
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Crct&Systs w/Lab	4
ECE 436	Digital Signal Pcsgr w/Lab	4
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 504	Wireless Comm Systm Design	3

ECE 507	Imaging Theory & Applications	3
ECE 508	Video Processing & Comm	3
ECE 509	Electromagnetic Field Theory	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 519	Coding Reliable Communications	3
ECE 522	Electromagnetic Compatibility	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	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 Syst	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	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 441	Microcomputers/Embedded Comp	4
ECE 443	Intro Computer Cyber Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Obj-Orntd Cmptr Sim	3
ECE 485	Computer Organization & Design	3
ECE 502	Basic Network Theory	3
ECE 521	Quantum Electronics	3
ECE 524	Adv Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Perform Anlys RF Intgrtd Crcts	3
ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
ECE 571	Nanodevices Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commcnctns	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Dctcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3

ECE 589	CAD of Analog IC	3
Master's Thesis Research		(6-8)
ECE 591	Research and Thesis M.S. ¹	6-8
General Electives		(0-2)
Select zero to two 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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 Envir Economics	3
Select a minimum of five courses from Groups A and B		15
Ph.D. Research		(24-36)
ECE 691	Research and Thesis 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

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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.

Gainful Employment Disclosure for the Certificate in Advanced Electronics

Curriculum

A maximum of two 400-level courses may be taken.

Code	Title	Credit Hours
Elective Courses		(12-13)
Select a minimum of four courses from the following:		12-13
ECE 411	Power Electronics	4
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 430	Fund of Semiconductor Devices	3
ECE 502	Basic Network Theory	3
ECE 521	Quantum Electronics	3
ECE 524	Adv Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Perform Anlys RF Intgrtd Crcts	3
ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 571	Nanodevices Technology	3
ECE 575	Electron Devices	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	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.

Gainful Employment Disclosure for the Certificate in Applied Electromagnetics

Curriculum

Code	Title	Credit Hours
Required Courses		(6-7)
ECE 421 or ECE 423	Microwave Circuits and Systems Microwave Crct&Systs w/Lab	3-4
ECE 509	Electromagnetic Field Theory	3
Elective Courses		(6)
Select a minimum of two courses from the following:		6
ECE 522	Electromagnetic Compatibility	3
ECE 571	Nanodevices 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.

Gainful Employment Disclosure for Certificate in Communication Systems

Curriculum

No more than one course may be a 400-level course.

Code	Title	Credit Hours
Required Courses		(6)
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
Elective Courses		(6-7)
Select a minimum of two courses from the following:		6-7
ECE 403	Digital & Data Comm Systems	3
ECE 405	Digital & Data Comm Syst w/Lab	4
ECE 406	Intro to Wireless Comm Systems	3
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Crct&Systs w/Lab	4
ECE 508	Video Processing & Comm	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf 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.

Gainful Employment Disclosure for Certificate in Computer Engineering

Curriculum

A maximum of one 400-level course may be taken, including ECE 429 if selected as a required course.

Code	Title	Credit Hours
Required Courses		(6-7)
ECE 429	Intro to VLSI Design	3-4
or ECE 529	Advncd VLSI Systems Dsgn	
ECE 585	Advanced Compt Arch	3
Elective Courses		(6-8)
Select a minimum of two courses from the following:		6-8
ECE 430	Fund of Semiconductor Devices	3

ECE 441	Microcomputers/Embedded Comp	4
ECE 443	Intro Computer Cyber Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Obj-Oriented Computer Sim	3
ECE 485	Computer Organization & Design	3
ECE 517	Wireless Network Protocols/Stand	3
ECE 529	Advanced VLSI Systems Design	3
ECE 530	High Performance VLSI/IC Systems	3
ECE 541	Performance Evaluation Computer Network	3
ECE 542	Design Optimization 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 Architectural Signal Processing Communications	3
ECE 586	Fault Detection Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Design	3
ECE 589	CAD 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, controllability and stability of systems, and analysis and synthesis of control systems.

Gainful Employment Disclosure for Certificate in Control Systems

Curriculum

Code	Title	Credit Hours
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 or ECE 506	Control Systems Analysis Nonlinear Systems	3
ECE 533	Robust Control	3
ECE 550	Power Electronics Dynamics 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.

Gainful Employment Disclosure for Certificate in Electricity Markets

Curriculum

Code	Title	Credit Hours
Power System Courses		(6)
Select a minimum of two courses from the following:		6
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
Finance Courses		(6)
Select a minimum of two courses from the following:		6
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/OTC Derivatives	3
MSF 554	Market Risk Management	3
MSF 584	Equity & Equity Deriv 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.

Gainful Employment Disclosure for Certificate in Power Electronics

Curriculum

Code	Title	Credit Hours
Required Courses		(6-7)
Select a minimum of two courses from the following:		6-7
ECE 411	Power Electronics	4
ECE 550	Power Elect Dynmcs 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 430	Fund of Semiconductor Devices	3
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	Cmpt Aided Dsgn Elec 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.

Gainful Employment Disclosure for Certificate in Power Engineering

Curriculum

Code	Title	Credit Hours
Required Courses		(3-4)
Select a minimum of one course from the following:		3-4
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 418	Power Systems Analysis	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3
Elective Courses		(9)
Select a minimum of three courses from the following:		9
ECE 417	Power Dist Engring	3
ECE 430	Fund of Semiconductor Devices	3
ECE 533	Robust Control	3
ECE 538	Renewable Energies	3
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 540	Relibilty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgn Engineering	3
ECE 564	Cntrl Oprtn Elect Power Systs	3
ECE 579	Oper/Plan/Dist Power Grid	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		12-13

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.

Gainful Employment Disclosure for Certificate in Signal Processing

Curriculum

Code	Title	Credit Hours
Required Courses		(6)
ECE 511	Analysis 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 Pcsgr w/Lab	4
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 507	Imaging Theory & Applications	3
ECE 508	Video Processing & Comm	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 568	Digital Speech Processing	3
ECE 584	VLSI Archs Sgnl Prcs Commnctns	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.

Gainful Employment Disclosure for Certificate in Wireless Communications Engineering

Curriculum

Code	Title	Credit Hours
Required Courses		(6)
ECE 504	Wireless Comm Systm Design	3
ECE 513	Commctn Engrg Fundamentals	3
Elective Courses		(6)
Select a minimum of two courses from the following:		6
ECE 403	Digital & Data Comm Systems	3
ECE 405	Digital & Data Comm Syst w/Lab	4
ECE 406	Intro to Wireless Comm Systems	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 517	Wireless Ntwrk Protocols/Stand	3
ECE 519	Coding Reliable Communications	3
ECE 520	Info Theory and Applications	3
ECE 544	Wireless and Mobile Networks	3
ECE 546	Wireless Network Security	3
ECE 547	Wireless Netwrks Perf Analysis	3

ECE 576	Antenna Theory	3
Total Credit Hours		12

Mechanical, Materials, and Aerospace Engineering

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 Chicago, IL 60616
 312.567.3175
mmae@iit.edu
engineering.iit.edu/mmae

Chair

Sumanta Acharya

Faculty with Research Interests

For more information regarding faculty visit the Department of Mechanical, Materials, and Aerospace Engineering website.

Illinois Institute of Technology's (Illinois Tech) Mechanical, Materials, and Aerospace Engineering (MMAE) Department today has an excellent group of tenured/tenure-track faculty with national and international reputations, memberships in the National Academy of Engineering (NAE), journal editorships, and fellowships/major awards from all relevant professional societies (e.g., ASME, AIAA, APS, TMS, ASM). There are currently 27 tenure/tenure-track and full-time instructional faculty in the MMAE department; in addition, there are a number of adjunct faculty who support the department's instructional and research missions. The major research strength areas are in the areas of dynamics and control, materials, fluid dynamics, thermal sciences, and mechanics.

The Dynamics & Control group is active in the area of autonomous systems with major funding/research-activity in navigation systems, robotics, self-driving cars, transportation systems, and others. This group houses major research laboratories in robotics, navigation, space weather, and transportation (engines).

The Materials group has research interests in material synthesis, material processing, and material design. The Thermal Processing of Materials Research Center is an industrial consortium supported by several industries. Other major laboratories and research areas include energy storage (e.g., batteries), energy conversion (e.g., thermoelectrics), high temperature materials and material coatings (e.g., nickel-alloys and thermal barrier coatings), ab-initio, MD and continuum calculations for material design, crystal growth, semiconductor materials and functional materials with unique thermal, acoustic, and structural properties.

The Fluid Dynamics group undertakes experimental and computational research in the areas of turbulence, shear flows, unsteady flows, flow control, flow-structure interactions, and noise. Application areas include aerospace, transportation, turbomachinery, biomedical, urban fluid dynamics, wind turbines, and power generation. Fluid dynamics facilities include the National Diagnostic Wind Tunnel Facility (NDF), the Morkovin and the Fejer wind tunnels, and compressed air facilities.

The Thermal Sciences group has activities in gas turbine heat transfer and aerodynamics, heat exchangers and energy-exchange systems, Internal Combustion (IC) engines, and crystal growth under terrestrial and microgravity conditions. Laboratory facilities include a fully-instrumented IC Engine Lab, Gas Turbine Heat Transfer Lab, and a laboratory for crystal growth studies.

The Mechanics group is involved with computational and experimental work including material design for phononic crystals, controlling acoustic (wave propagation) in solids, new computational approaches for multi-scale solid mechanics, optimization, dynamic response of solids, constitutive models, and microstructural characterization under loading. The department houses the Dynamic Testing Laboratory with servo-hydraulic, drop tower, and high temperature testing facilities and associated diagnostics.

Additional information on the Mechanical, Materials and Aerospace Engineering (MMAE) Department can be found on its website (engineering.iit.edu/mmae).

Research Centers

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; laboratories in experimental mechanics; laboratories for research in robotics, guidance and navigation, computer integrated manufacturing, 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, and 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, and 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-aided 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, and robotics devices for laser machining; and dynamic analysis and control of complex systems.

Admission Requirements

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

300 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

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 (John T. Rettaliata Engineering Center, Suite 243) 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 Ph.D. students and M.S. students engaged in thesis research are required to register each semester for the departmental seminar MMAE 593.

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 nine credit hours of study. Maintaining the minimum GPA requirement does not guarantee admission to MMAE graduate degree programs. A maximum of nine 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.

Degrees Offered

- Master of Computational Engineering, Computational Mechanics Track (p. 203)
- Master of Engineering Management, Product Design and Development Track (p. 204)
- Master of Engineering in Advanced Manufacturing
 - Additive Manufacturing Track (p. 205)
 - Digital Manufacturing Track (p. 205)
- Master of Engineering in Energy Systems, Energy Generation and Sustainability Track (p. 206)
- Master of Engineering in Manufacturing Engineering (p. 208)
- Master of Engineering in Manufacturing Engineering via Internet (p. 209)
- Master of Engineering in Materials Science and Engineering (p. 209)
- Master of Engineering in Mechanical and Aerospace Engineering (p. 210)
- Master of Science in Autonomous Systems and Robotics (p. 211)

- Master of Science in Manufacturing Engineering (p. 213)
- Master of Science in Materials Science and Engineering (p. 216)
- Master of Science in Mechanical and Aerospace Engineering (p. 217)
- Doctor of Philosophy in Materials Science and Engineering (p. 228)
- Doctor of Philosophy in Mechanical and Aerospace Engineering (p. 229)

Interdisciplinary Programs

- Master of Engineering in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3) (p. 218)
- Master of Engineering in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (p. 220)
- Master of Science in Materials Science and Engineering with Specialization in Energy/Environment/Economics (E3) (p. 218)
- Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (p. 220)

Certificate Program

- Computer Integrated Design and Manufacturing (p. 231)
- Product Quality and Reliability Assurance (p. 231)

Course Descriptions

ENGR 502

Medical Device Regulations and Commercialization

This course helps prepare students for commercializing medical devices within a highly-regulated environment. Concepts include protecting intellectual property, the structure and scope of the Federal Drug Administration (FDA), developing, testing, producing and marketing medical devices under FDA regulations, total product lifecycle, and quality management.

Lecture: 3 Lab: 0 Credits: 3

ENGR 510

Strategic Engineering Management

This course will review technology-based enterprises and the driving forces that impact corporate strategy. Students will learn how to apply engineering knowledge to determine technology/product direction and make/buy/partnering decisions. Relationships between research and development, operations, finance, marketing, and other functions within engineering-based organizations that drive strategic decisions will be examined. Strategy development and competitive analysis will be included. Case studies from the industry relevant to the student's engineering track will be reviewed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 520

Best Practices in Engineering Project Management

Many engineering projects suffer due to weak business cases, schedule slippages, and cost overruns. This course presents commonly used tools and techniques and best practices to build an effective business case, develop a realistic schedule and budget, and successfully execute and complete a project. Students are introduced to a generic project management life cycle model, review basic project management principles, tools, and techniques, and learn engineering-tailored best practices used by high performing, project-centric organizations. Students have an opportunity to apply selected tools in the form of short classroom exercises.

Lecture: 3 Lab: 0 Credits: 3

ENGR 521

Risk Management in Engineering Projects

In project management, a risk is considered an uncertain event that may have a positive or a negative impact on project objectives. Managing identified threats individually through customized strategies is key to project success. Similarly, opportunities must be leveraged for better project outcomes. Implementation of an effective risk management process is imperative for today's complex projects. This course presents a five-step process to manage project threats as well as opportunities. On every project, students will be able to identify and analyze risks and develop response strategies for each identified risk and take proper response action to manage the risks. Industry best practices and quantitative tools and simulations are used to analyze risk.

Lecture: 3 Lab: 0 Credits: 3

ENGR 531

Urban Systems Engineering Design

ENGR 531 is a project-based course where students will explore integrated designs of urban systems. Each project will apply the students' engineering disciplines (such as structures, transportation, building science, construction engineering and management, environmental engineering) in a comprehensive analysis that considers the economic, human, and environmental issues associated with the project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 532

Urban Systems Engineering Seminar

ENGR 532 is an active seminar course that emphasizes current topics in urban systems engineering. Invited speakers will include researchers and representatives from current practice, such as municipal and regional planners and consultants. Appropriate readings will be assigned in advance of each speaker to guide students in preparation for active discussion with each speaker. Each student will also write a term paper on an urban systems engineering topic of their choice, connecting material from the assigned reading, the speakers, and additional references selected by the student.

Lecture: 3 Lab: 0 Credits: 3

ENGR 534

Product Design and Innovation

This course covers all aspects of planning new products or services that are commercially viable and add to a company's suite of offerings. It includes such topics as user research, market analysis, need/problem identification, creative thinking, ideation, concepting, competitive benchmarking, human factors, prototyping, evaluation, and testing. The course includes creative, analytical, and technical skills in a balanced approach using such teaching methods as case studies, individual exercises, and group projects.

Lecture: 3 Lab: 0 Credits: 3

ENGR 539

Robotic Motion Planning

Configuration space. Path planning techniques including potential field functions, roadmaps, cell decomposition, and sampling-based algorithms. Kalman filtering. Probabilistic localization techniques using Bayesian methods. Trajectory planning.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 573**Construction Contract Administration**

Characteristics of the construction industry. Project delivery systems. Duties and liabilities of the parties at the pre-contract stage. Bidding. Contract administration including duties and liabilities of the parties regarding payments, retainage, substantial and final completion, scheduling and time extensions, change orders, changed conditions, suspension of work, contract termination, and resolution of disputes. Contract bonds. Managing the construction company. Labor law and labor relations.

Lecture: 3 Lab: 0 Credits: 3

ENGR 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

ENGR 575**Systems Analysis in 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

ENGR 576**Nano Manufacturing**

This course covers the general methods used for micro- and nano-fabrication and assembly, including photolithography techniques, physical and chemical deposition methods, masking, etching, and bulk micromachining as well as self-assembly techniques. It also covers nanotubes, nanowires, nanoparticles, and the devices that use them, including both electronic and mechanical-electronic systems, as well as nano-structural materials and composites. Focus is on commercially available current processes as well as emerging technologies and evolving research areas. Sensing and instrumentation as well as nano-positioning and actuation are covered briefly.

Lecture: 3 Lab: 0 Credits: 3

ENGR 587**Introduction to Digital Manufacturing**

This course is about the digital revolution taking place in the world of manufacturing and how students, workers, managers, and business owners can benefit from the sweeping technological changes taking place. It is about the change from paper-based processes to digital-based processes all through the design/manufacturing/deliver enterprise, and across the global supply chain. It touches on digital design, digital manufacturing engineering, digital production, digital quality assurance, and digital contracting, from large companies to small. There is also a significant focus on cyber security and the new types of threats that manufacturers face in the new digital world. Other topics covered include intelligent machines, connectivity, the digital thread, big data, and the Industrial Internet of Things (IIoT).

Lecture: 3 Lab: 0 Credits: 3

ENGR 588**Additive Manufacturing**

This course examines the fundamentals of a variety of additive manufacturing processes as well as design for additive manufacturing, materials available, and properties and limitations of materials and designs. It also examines the economics of additive manufacturing as compared to traditional subtractive manufacturing and other traditional techniques. Additive techniques discussed include 3D printing, selective laser sintering, stereo lithography, multi-jet modeling, laminated object manufacturing, and others. Advantages and limitations of all current additive technologies are examined as well as criteria for process selection. Processes for metals, polymers, and ceramics are covered. Other topics include software tools and connections between design and production, direct tooling, and direct manufacturing. Current research trends are discussed.

Lecture: 3 Lab: 0 Credits: 3

ENGR 592**Engineering Management Capstone Experience**

Students apply the knowledge they have acquired in the Engineering Management program to a specific problem or case study. Projects will be identified and mentored in conjunction with faculty and industrial partners. A final report or business plan is required that reflects the focus of the capstone project.

Lecture: 3 Lab: 0 Credits: 3

ENGR 595**Product Development for Entrepreneurs**

Elements of product development (mechanical and electrical), manufacturing and production planning, supply chain, marketing, product research, and entrepreneurship concepts are taught in this class. In this course, student teams will be required to create a compelling product that has potential to be sold in today's marketplace. They will be required to create functional prototypes of their product for people to use and critique. If successful, students will be allowed to put their product on Kickstarter.com and take orders for delivery after the class is complete while potentially fostering their own business as a result of this course.

Lecture: 3 Lab: 0 Credits: 3

ENGR 596**Practical Engineering Training**

This course is a mentored, immersive practical engineering training. Students learn under the direction of professional engineers and practicing engineers by working on real engineering projects. The student will perform hands-on engineering, including learning and developing/applying engineering principles and concepts to complete the project assigned to the student. The student will apply engineering ethics and safety during their practical engineering training. Students will communicate the results of their work in written and oral communications. Students will receive assignments of varying complexity consistent with their graduate standing.

Lecture: 0 Lab: 9 Credits: 3

ENGR 598**Graduate Research Immersion: Team Project**

This course provides a faculty-mentored immersive team-based research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

ENGR 599**Graduate Research Immersion: Individual**

This course provides a faculty-mentored immersive research experience. Research topics are determined by the faculty mentor's area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.

Lecture: 3 Lab: 0 Credits: 3

MMAE 500**Data Driven Modeling**

This graduate level course focuses on the state of the art techniques in data driven modeling. The course covers an introduction to probability theory, elements of optimization, machine learning basics, deep learning basics including an introduction to learning methodologies and algorithms, elements of modern neural network architectures, and advanced topics in data driven modeling. The emphasis will be squarely on the application of modern data driven modeling tools to advanced engineering problems related to mechanics, dynamics, and controls.

Corequisite(s): MMAE 501

Prerequisite(s): MMAE 350 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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* with min. grade of C, 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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 510 with min. grade of C and MMAE 502 with min. grade of C

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 with min. grade of C

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 510 with min. grade of C and MMAE 501 with min. grade of C

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**Conduction and Diffusion**

Heat conduction and Fourier's law. Diffusion and Fick's 1st law. Random walk. Thermal conductivity and diffusion coefficients in solids, liquids and gases. Stokes-Einstein equation. Non-continuum effects and nano-scale transport. Resistances in heat conduction & electrical analogy. Multi-dimensional conduction and diffusion problems. Transient heat conduction and diffusion equation. Fick's 2nd law. Analytical and numerical solution approaches for conduction and diffusion equations (Fourier series, Bessels functions, etc). Sources and sinks in conduction and diffusion including reactions.

Prerequisite(s): MMAE 525 with min. grade of C and MMAE 502 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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* with min. grade of C, 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 with min. grade of C

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 with min. grade of C or MMAE 451 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MMAE 533**Fatigue and Fracture Mechanisms**

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 534**Product Design and Innovation**

This course covers all aspects of planning new products or services that are commercially viable and add to a company's suite of offerings. It includes such topics as user research, market analysis, need/problem identification, creative thinking, ideation, concepting, competitive benchmarking, human factors, prototyping, evaluation, and testing. The course includes creative, analytical, and technical skills in a balanced approach using such teaching methods as case studies, individual exercises, and group projects.

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; moiré 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 539**Robotic Motion Planning**

Configuration space. Path planning techniques including potential field functions, roadmaps, cell decomposition, and sampling-based algorithms. Kalman filtering. Probabilistic localization techniques using Bayesian methods. Trajectory planning. Homework and project will require extensive programming in Matlab or similar environment.

Lecture: 3 Lab: 0 Credits: 3

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 501* with min. grade of C and MMAE 443 with min. grade of C, 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* with min. grade of C, 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 with min. grade of C

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* with min. grade of C, 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. MMAE 445 (with min. grade of C)/equivalent or instructor consent as prerequisite of MMAE545.

Prerequisite(s): MMAE 445 with min. grade of C

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. Undergraduate engineering degree or concurrent enrollment in undergraduate engineering program or consent of instructor.

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. Prerequisite: Undergraduate engineering degree or concurrent enrollment in undergraduate engineering program or consent of instructor.

Lecture: 3 Lab: 0 Credits: 3

MMAE 549**Optimal Control**

The course focuses on unconstrained and constrained optimal control problems for linear and non-linear deterministic systems. It uses basic optimization and principles of optimal control. The course covers introduction to convex optimization and nonlinear systems, dynamic programming, variational calculus, approaches based on Pontryagin's minimum principle, and model predictive control.

Prerequisite(s): MMAE 543 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MMAE 550**Optimal State Estimation**

Probability and random variables. Stochastic dynamic systems. Kalman filters, information forms, and smoothers. Covariance analysis. Bayesian, adaptive, and nonlinear estimation. Detection theory. Applications to guidance, navigation, and control systems.

Prerequisite(s): MMAE 501* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

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.

Lecture: 2 Lab: 3 Credits: 3

MMAE 552**Intro 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 501* with min. grade of C and MMAE 443 with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

MMAE 556**Nano Manufacturing**

This course covers the general methods used for micro- and nano-fabrication and assembly including photolithography techniques, physical and chemical deposition methods, masking, etching, and bulk micromachining as well as self-assembly techniques. It also covers nanotubes, nanowires, nanoparticles, and the devices that use them including both electronic and mechanical-electronic systems as well as nano-structural materials and composites. Focus is on commercially available current processes as well as emerging technologies and evolving research areas. Sensing and instrumentation as well as nano-positioning and actuation are covered briefly.

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.

Prerequisite: Undergraduate engineering degree or concurrent enrollment in undergraduate engineering program or consent of instructor.

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. **Prerequisite:** Undergraduate engineering degree or concurrent enrollment in undergraduate engineering program or consent of instructor.

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, Kyropoulos, 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 with min. grade of C

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 572**Crystallography and Crystal Defect**

Geometrical crystallography - formal definitions of lattices, systems, point groups, etc. Mathematical methods of crystallographic analysis. Diffraction techniques: X-ray, electron and neutron diffraction. Crystal defects and their influence on crystal growth and crystal properties.

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.

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 586**Advanced Failure Analysis**

Comprehensive coverage of both the "how" and "why" of metal and ceramic failures. Intellectual tools and understanding needed to analyze failures. Analytical methods including stress analysis, fracture mechanics, fatigue analysis, creep mechanisms, corrosion science, and nondestructive testing. Numerous case studies illustrating the application of basic principles of materials science and failure analysis to a wide variety of real-world situations.

Lecture: 3 Lab: 0 Credits: 3

MMAE 587**Introduction to Digital Manufacturing**

This course is about the digital revolution taking place in the world of manufacturing and how students, workers, managers, and business owners can benefit from the sweeping technological changes taking place. It is about the change from paper-based processes to digital-based processes all through the design/manufacturing/deliver enterprise and across the global supply chain. It touches on digital design, digital manufacturing engineering, digital production, digital quality assurance, and digital contracting from large companies to small. There is also a significant focus on cyber security and the new types of threats that manufacturers face in the new digital world. Other topics covered include intelligent machines, connectivity, the digital thread, big data, and the Industrial Internet of Things (IIoT).

Lecture: 3 Lab: 0 Credits: 3

MMAE 588**Additive Manufacturing**

This course examines the fundamentals of a variety of additive manufacturing processes as well as design for additive manufacturing, materials available, and properties and limitations of materials and designs. It also examines the economics of additive manufacturing as compared to traditional subtractive manufacturing and other traditional techniques. Additive techniques discussed include 3D printing, selective laser sintering, stereo lithography, multi-jet modeling, laminated object manufacturing, and others. Advantages and limitations of all current additive technologies are examined as well as criteria for process selection. Processes for metals, polymers, and ceramics are covered. Other topics include software tools and connections between design and production, direct tooling, and direct manufacturing. Current research trends are discussed.

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. Prerequisite: Undergraduate engineering degree or concurrent enrollment in undergraduate engineering program or consent of instructor.

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. Prerequisite: Undergraduate engineering degree or concurrent enrollment in undergraduate engineering program or consent of instructor.

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 596**Semiconductors for Energy Generation**

The course focus on advanced topics of two energy generation applications of semiconductors: photovoltaics and thermoelectrics. The goal is to understand the fundamental physics behind material behaviors. Topics include: Basic of semiconductors. Excitation and recombination process. Electron and phonon transport. Scattering mechanisms. Thermodynamics and statistical mechanics of electron and phonon systems. Boltzmann transport equations. Measurement techniques, Review of emerging materials. requires: MS201 minimum C. recommended preparation: MMAE 362 Physics of Solids, or PHYS 437 Solid State Physics.

Prerequisite(s): MS 201 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

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: 1 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 with min. grade of C

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 Computational Engineering, Computational Mechanics Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
Select nine credit hours from the following courses:		9
BME 522	Math Methods in BME	3
BME 553	Quantitative Physiology	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 536	Computational Techniques Engg	3
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Computational Mechanics Courses		(12)
Select 12 credit hours from the following courses:		12
CAE 530	Finite Element Method of Anlys	3
CAE 534	Computational Techniques	3
CAE 535	Nonlinear Finite Element Anlys	3
CAE 597	Special Problems	1-6
CHE 536	Computational Techniques Engg	3
CHE 560	Ststcl Qlty Process Control	3
MMAE 450	Computational Mechanics II	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 518	Spec Methods Comp Fluid Dynmcs	3
MMAE 532	Finite Element Methods II	3
MMAE 570	Computational Methods in MSE	3
MMAE 597	Special Topics	1-6
Elective Courses		(9)
Select nine credit hours from the following courses: ¹		9
BME 445	Quantitative Neural Function	3
BME 522	Math Methods in BME	3
BME 523	Cell Biomechanics	3
BME 524	Quant Aspects Cell/Tissue Engg	3
BME 525	Introduction to Medical Device	3
BME 538	Neuroimaging	3
BME 553	Quantitative Physiology	3
BME 597	Special Problems	1-6
CAE 530	Finite Element Method of Anlys	3
CAE 534	Computational Techniques	3
CAE 535	Nonlinear Finite Element Anlys	3
CAE 597	Special Problems	1-6
CHE 439	Numerical Data Analysis	3
CHE 506	Entrepreneurship & IP Mgmt	3
CHE 516/BME 517	Tech for Treatment of Diabetes	3
CHE 535	Applctn Math Cheml Engrg	3
CHE 536	Computational Techniques Engg	3

CHE 560	Ststcl Qlty Process Control	3
CHE 585	Drug Delivery	3
CHE 597	Special Problems	1-6
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
ECE 533	Robust Control	3
ECE 535	Discrete Time Systems	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	3
ECE 567	Statistical Signal Processing	3
ECE 597	Special Problems	1-6
MATH 577	Computational Mathematics I	3
MATH 581	Finite Element Method	3
MMAE 450	Computational Mechanics II	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
MMAE 508	Perturbation Methods	3
MMAE 509	Intro to Continuum Mechanics	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 518	Spec Methods Comp Fluid Dynmcs	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
MMAE 594	Proj for Master of Engg Stud	1-6
MMAE 597	Special Topics	1-6
Total Credit Hours		30

¹ Course must not have been used towards the core course or specialization course requirements.

Master of Engineering Management, Product Design and Development Track

Curriculum

Code	Title	Credit Hours
Core Courses		(15)
EMGT 470	Project Management	3
CAE/ENGR 574	Economic Decision Analysis	3
CAE/ENGR 575	Systems Analysis in Civil Engg	3
ENGR 510	Strategic Engineering Mgmt	3
ENGR 592	Engg Management Capstone Exp	3
Product Design and Development Courses		(9)
Select nine credit hours from the following courses:		9
BUS 472	New Product Development	3
CAE 523	Statistical Analysis Engg Data	3
CHE 506	Entrepreneurship & IP Mgmt	3
ENGR 502	Medical Device Regs/Commer	3
ENGR 595	Product Development	3
IDX 561	Intro to Design Concepts	3
MMAE 560	Ststcl Quality Procs Control	3
MMAE 589	Apps in Reliability Engg I	3

Elective Courses**(6)**

Select six credit hours from any 500-level BME, CHE, CAE, ECE, EG, ENVE, or MMAE engineering course.

6

Total Credit Hours

30

Master of Engineering in Advanced Manufacturing, Additive Manufacturing Track

Curriculum

Code	Title	Credit Hours
Core Courses		(12-14)
MMAE 501	Engineering Analysis I	3
Select 9-11 credit hours from the following courses:		9-11
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 547	Comp Intgrtd Manuf Technlgies	3
MMAE 557	Comp Intgrtd Manfctrng Sysms	3
MMAE 560	Ststcl Quality Procs Control	3
Additive Manufacturing Courses		(9)
Select nine credit hours from the following courses:		9
MMAE 445	Computer-Aided Design	3
MMAE 545	Advanced CAD/CAM	3
MMAE 579	Advanced Materials Processing	3
MMAE/ENGR 588	Additive Manufacturing	3
Elective Courses		(7-9)
Select seven to nine credit hours from the following courses:		7-9
ECE 594 or MMAE 594	Special Projects Proj for Master of Engg Stud	1-6
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 502	Engineering Analysis II	3
MMAE 532	Finite Element Methods II	3
MMAE 541	Advanced Dynamics	3
MMAE 570	Computational Methods in MSE	3
MMAE 589	Apps in Reliability Engg I	3
MMAE 590	Apps Reliabilty Engineering II	3

Minimum degree credits required: 30

Master of Engineering in Advanced Manufacturing, Digital Manufacturing Track

Curriculum

Code	Title	Credit Hours
Core Courses		(12-14)
MMAE 501	Engineering Analysis I	3
Select 9-11 credit hours from the following courses:		9-11
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 438	Control Systems	3

ECE 505	Applied Optimization Engrgs	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 547	Comp Intgrtd Manuf Technlgies	3
MMAE 557	Comp Intgrtd Manfctrng Sysms	3
MMAE 560	Ststcl Quality Procs Control	3
Digital Manufacturing Courses		(9)
Select nine credit hours from the following courses:		9
ECE 565	Compt Vision Image Processing	3
ENGR/MMAE 539	Robotic Motion Planning	3
ENGR/MMAE 587	Intro to Digital Manufacturing	3
MMAE 445	Computer-Aided Design	3
MMAE 543	Modern Control Systems	3
MMAE 545	Advanced CAD/CAM	3
MMAE 587	Intro to Digital Manufacturing	3
Elective Courses		(7-9)
Select seven to nine credit hours from the following courses:		7-9
ENGR 595	Product Development	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 502	Engineering Analysis II	3
MMAE 532	Finite Element Methods II	3
MMAE 541	Advanced Dynamics	3
MMAE 570	Computational Methods in MSE	3
MMAE 589	Apps in Reliability Engg I	3
MMAE 590	Apps Reliabilty Engineering II	3
MMAE 594	Proj for Master of Engg Stud	1-6

Minimum degree credits required: 30

Master of Engineering in Energy Systems, Energy Generation and Sustainability Track

Curriculum

Code	Title	Credit Hours
Core Courses		(9)
CHE 543	Energy Envir Economics	3
ECE 418	Power Systems Analysis	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
Energy Generation and Sustainability Courses		(12-14)
Select 12-14 credit hours from the following courses:		12-14
CHE 541	Renwble Enrgy Technologies	3
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 552	Adjustable Speed Drives	3
ECE 580	Elements of Sustainable Energy	3
MMAE 425	Direct Energy Conversion	3
MMAE 433	Design of Thermal Systems	3
MMAE 453	Adv Automotive Powertrains	3
MMAE 523	Fundamentals Power Generation	3
Elective Courses		(7-9)
Select seven to nine credit hours from the following courses: ¹		7-9
CAE 513	Building Science	3

CAE 515	BIM Applications for Bldg Perf	3
CAE 526	Energy Conservation Dsgn:Bldgs	3
CHE 541	Renwble Enrgy Technologies	3
ECE 411	Power Electronics	4
ECE 412	Hybrid Electric Vehicle Drives	4
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 564	Cntrl Oprtn Elect Power Sys	3
ECE 580	Elements of Sustainable Energy	3
ECE 581	Elements of Smart Grid	3
ECE 582	Microgrid Design and Operation	3
ECE 597	Special Problems	1-3
MMAE 425	Direct Energy Conversion	3
MMAE 433	Design of Thermal Systems	3
MMAE 453	Adv Automotive Powertrains	3
MMAE 523	Fundamentals Power Generation	3
MMAE 525	Fundamentals of Heat Transfer	3

Minimum Degree Credits Required: 30

¹ Course must not have been used to fulfill specialization course requirement.

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 their adviser, prepares a program of study that reflects individual needs and interests. The adviser, as well as the department's graduate studies committee, and the department chair must approve this program. Students working toward this degree are not eligible for departmental financial support.

Curriculum

Materials Science and Engineering Emphasis

Code	Title	Credit Hours
Required Courses		(12)
MMAE 547	Comp Intgrtd Manuf Technlgies	3
MMAE 560	Ststcl Quality Procs 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	Adv Manufacturing Engineering	3
MMAE 576	Materials Process Selection	3
Select a minimum of one course from the following numerical methods courses:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
Elective Courses		(18)
Select 18 credit hours		18
Total Credit Hours		30

Mechanical and Aerospace Engineering Emphasis

Code	Title	Credit Hours
Required Courses		(18)
MMAE 545	Advanced CAD/CAM	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 547	Comp Intgrtd Manuf Technlgies	3
or MMAE 557	Comp Intgrtd Manfctrng Systems	
MMAE 560	Ststcl Quality Procs Control	3
Select a minimum of one course from the following:		3
MMAE 445	Computer-Aided Design	3
MMAE 576	Materials Process Selection	3
MMAE 585	Engg Optics & Laser-Based Manu	3
Select a minimum of one course from the following numerical methods courses:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	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

Code	Title	Credit Hours
Required Courses		(17)
MMAE 545	Advanced CAD/CAM	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 560	Ststcl Quality Procs Control	3
MMAE 547	Comp Intgrtd Manuf Technlgies	3
or MMAE 557	Comp Intgrtd Manfctrng Systms	
MMAE 563	Advanced Mechanical Metallurgy (materials course)	3
MMAE 704	Intro Finite Elmnt Anlys (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	Comp Intgrtd Manfctrng Systms	3
MMAE 589	Apps in Reliability Engg I	3
MMAE 590	Apps Reliabilty 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 their adviser, prepares a program of study that reflects individual needs and interests. The adviser, as well as the department's graduate studies committee, and the department chair must approve this program. Students working toward this degree are not eligible for departmental financial support.

Curriculum

Code	Title	Credit Hours
Required Courses		(18)
Select a minimum of six courses from the following:		18
MMAE 461	Failure Analysis	3
MMAE 470	Intro to Polymer Science	3
MMAE 472	Advanced Aerospace Materials	3
MMAE 501	Engineering Analysis I	3
MMAE 520	Advanced Thermodynamics	3
MMAE 533	Fatigue & Fracture Mechanisms	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 562	Design Modern Alloys	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 564	Dislocations/Strengthening Mec	3
MMAE 565	Materials Laboratory	3
MMAE 566	Pblms High Tempte Materials	3
MMAE 567	Fracture Mechanisms	3
MMAE 568	Diffusion	2

MMAE 569	Advanced Physical Metallurgy	3
MMAE 570	Computational Methods in MSE	3
MMAE 576	Materials Process Selection	3
MMAE 578	Fiber Composites	3
MMAE 579	Advanced Materials Processing	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 12 credit hours of 400-level courses, as long as they were not used to satisfy requirements for an undergraduate degree. Up to six 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 their adviser, prepares a program of study that reflects individual needs and interests. The adviser, as well as the department's graduate studies committee, and the department chair must approve this program. Students working toward this degree are not eligible for departmental financial support.

Curriculum

Code	Title	Credit Hours
Required Courses		(6-7)
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 Elmnt Methods in Engrg	3
MMAE 500	Data Driven Modeling	3
MMAE 502	Engineering Analysis II	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	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

Code	Title	Credit Hours
Fluid Dynamics		(4)
MMAE 510	Fundmntls of Fluid Mechanics	4
Thermal Sciences		(3)
MMAE 520	Advanced Thermodynamics	3
or MMAE 525	Fundamentals of Heat Transfer	
Solids and Structures		(3)
MMAE 530	Advanced Mechanics 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 nine credit hours at the 400-level are allowed, assuming the courses were not required for an undergraduate degree. Up to six credit hours of accelerated (700-level) courses are allowed.

Master of Science in Autonomous Systems and Robotics

The master of science degree program advances knowledge through post-baccalaureate coursework. The program requires 32 credit hours. Students have the option of completing a thesis based on up to eight credit hours of research (MMAE 591) with the approval of a thesis adviser, or completing the program with courses, which may include up to six credit hours of projects (MMAE 594). In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with their adviser, in formulating an M.S. program. Registration and 80%-class session attendance—required for a passing grade—in the Seminar course MMAE 593 is required of all M.S. graduate students (Non-thesis or Thesis) and Ph.D. students. A satisfactory grade is required, in each semester of full-time enrollment, to fulfill degree requirements.

The above requirement reflects the change that "Students doing the MENG degree programs or non-thesis MS degree program are no longer required to attend the seminar for graduation requirements." This change was approved by the MMAE faculty via a formal vote.

Before completion of the first semester of graduate study, full-time students should select 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 as well as the department's graduate studies committee and the department chair must approve this program. Students with the thesis option are required to pass an oral comprehensive examination on their 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.

Master of Science in Autonomous Systems and Robotics (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(9)
MMAE 501	Engineering Analysis I	3
MMAE 541	Advanced Dynamics	3
MMAE 543	Modern Control Systems	3
Autonomous Systems and Robotics (ASR) Electives		(23)
Select 23 credit hours from the following:		23
MMAE 410	Aircraft Flight Mechanics	3
MMAE 411	Spacecraft Dynamics	3
MMAE 445	Computer-Aided Design	3
MMAE 500	Data Driven Modeling	3
MMAE 502	Engineering Analysis II	3
MMAE 539	Robotic Motion Planning	3
MMAE 540	Robotics	3
MMAE 545	Advanced CAD/CAM	3
MMAE 549	Optimal Control	3
MMAE 550	Optimal State Estimation	3
MMAE 552	Intro to the Space Environment	3
MMAE 555	Intro to Navigation Systems	3
MMAE 594	Proj for Master of Engg Stud	1-3
MMAE 597	Special Topics	1-3
ECE 505	Applied Optimization Engrgs	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Machine and Deep Learning	3
ECE 567	Statistical Signal Processing	3

CS 557	Cyber-Physical Sys Sec/Dsgn	3
CS 584	Machine Learning	3
MATH 484	Regression	3
MATH 545	Stochastic Partial Diff Equatn	3
MATH 554	Discrete Applied Math II	3
MATH 564	Applied Statistics	3
MATH 574	Bayesian Computational Stats	3
MATH 574	Bayesian Computational Stats	3
Total Credit Hours		32

¹ A course may not be chosen if it is already being applied to the ASR elective course requirement.

Master of Science in Autonomous Systems and Robotics (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(9)
MMAE 501	Engineering Analysis I	3
MMAE 541	Advanced Dynamics	3
MMAE 543	Modern Control Systems	3
Autonomous Systems and Robotics (ASR) Electives		(15-17)
Select 15-17 credit hours from the following:		15-17
MMAE 410	Aircraft Flight Mechanics	3
MMAE 411	Spacecraft Dynamics	3
MMAE 445	Computer-Aided Design	3
MMAE 500	Data Driven Modeling	3
MMAE 502	Engineering Analysis II	3
MMAE 539	Robotic Motion Planning	3
MMAE 540	Robotics	3
MMAE 545	Advanced CAD/CAM	3
MMAE 549	Optimal Control	3
MMAE 550	Optimal State Estimation	3
MMAE 552	Intro to the Space Environment	3
MMAE 555	Intro to Navigation Systems	3
MMAE 597	Special Topics	1-3
CS 584	Machine Learning	3
ECE 505	Applied Optimization Engrgs	3
CS 557	Cyber-Physical Sys Sec/Dsgn	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Machine and Deep Learning	3
ECE 567	Statistical Signal Processing	3
MATH 484	Regression	3
MATH 564	Applied Statistics	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Stats	3
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

¹ A course may not be chosen if it is already being applied to the ASAR elective course requirements.

Master of Science in Manufacturing Engineering

The master of science degree program advances knowledge through post-baccalaureate coursework. The program requires 32 credit hours. Students have the option of completing a thesis based on up to eight credit hours of research (MMAE 591) with the approval of a thesis adviser, or completing the program with courses, which may include up to six credit hours of projects (MMAE 594). In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with their adviser, in formulating an M.S. program. Registration and 80%-class session attendance—required for a passing grade—in the Seminar course MMAE 593 is required of all M.S. graduate students (Non-thesis or Thesis) and Ph.D. students. A satisfactory grade is required, in each semester of full-time enrollment, to fulfill degree requirements.

The above requirement reflects the change that "Students doing the MENG degree programs or non-thesis MS degree program are no longer required to attend the seminar for graduation requirements." This change was approved by the MMAE faculty via a formal vote.

Before completion of the first semester of graduate study, full-time students should select 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 as well as the department's graduate studies committee and the department chair must approve this program. Students with the thesis option are required to pass an oral comprehensive examination on their 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.

Master of Science in Manufacturing Engineering, Materials Science and Engineering Emphasis (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(18)
MMAE 547 or MMAE 557	Comp Intgrtd Manuf Technlgies Comp Intgrtd Manfctrng Systms	3
MMAE 560	Ststcl Quality Procs Control	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 569	Advanced Physical Metallurgy	3
Select a minimum of three credit hours from the following:		3
MMAE 445	Computer-Aided Design	3
MMAE 545	Advanced CAD/CAM	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 576	Materials Process Selection	3
Select a minimum of three credit hours from the following:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
Elective Courses		(14)
Select 14 credit hours of 400-level and above MMAE courses ¹		14

¹ Students may include up to six credit hours of MMAE 594. Up to three credit hours of INTM courses may be used with adviser approval.

Master of Science in Manufacturing Engineering, Materials Science and Engineering Emphasis (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(18)
MMAE 547 or MMAE 557	Comp Intgrtd Manuf Technlgies Comp Intgrtd Manfctrng Systems	3
MMAE 560	Ststcl Quality Procs Control	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 569	Advanced Physical Metallurgy	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	Adv Manufacturing Engineering	3
MMAE 576	Materials Process Selection	3
Select a minimum of one course from the following numerical methods courses:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
Elective Courses		(6-8)
Select six to eight credit hours of 400-level and above MMAE courses ¹		6-8
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

¹ Students may include up to six credit hours of MMAE 594. Up to three credit hours of INTM courses may be used with adviser approval.

Master of Science in Manufacturing Engineering, Mechanical and Aerospace Engineering Emphasis (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(18)
MMAE 545	Advanced CAD/CAM	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 547 or MMAE 557	Comp Intgrtd Manuf Technlgies Comp Intgrtd Manfctrng Systems	3
MMAE 560	Ststcl Quality Procs Control	3
Select a minimum of three credit hours from the following:		3
MMAE 445	Computer-Aided Design	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 569	Advanced Physical Metallurgy	3

MMAE 576	Materials Process Selection	3
Select a minimum of three credit hours from the following:		3
MMAE 445	Computer-Aided Design	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
Elective Courses		(14)
Select 14 credit hours of 400-level and above MMAE courses ¹		14

¹ Students may include up to six credit hours of MMAE 594. Up to three credit hours of INTM courses may be used with adviser approval.

Master of Science in Manufacturing Engineering, Mechanical and Aerospace Engineering Emphasis (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(18)
MMAE 545	Advanced CAD/CAM	3
MMAE 546	Adv Manufacturing Engineering	3
MMAE 547	Comp Intgrtd Manuf Technlgies	3
or MMAE 557	Comp Intgrtd Manfctrng Systems	
MMAE 560	Ststcl Quality Procs Control	3
Select a minimum of one course from the following:		3
MMAE 445	Computer-Aided Design	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 569	Advanced Physical Metallurgy	3
MMAE 576	Materials Process Selection	3
Select a minimum of one course from the following:		3
MMAE 445	Computer-Aided Design	3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
Elective Courses		(6-8)
Select six to eight credit hours of 400-level and above MMAE courses ¹		6-8
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

¹ Students may include up to six credit hours of MMAE 594. Up to three credit hours of INTM courses may be used with adviser approval.

Master of Science in Materials Science and Engineering

The master of science degree program advances knowledge through post-baccalaureate coursework. The program requires 32 credit hours. Students have the option of completing a thesis based on up to eight credit hours of research (MMAE 591) with the approval of a thesis adviser, or completing the program with courses, which may include up to six credit hours of projects (MMAE 594). In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with their adviser, in formulating an M.S. program. Registration and 80%-class session attendance—required for a passing grade—in the Seminar course MMAE 593 is required of all M.S. graduate students (Non-thesis or Thesis) and Ph.D. students. A satisfactory grade is required, in each semester of full-time enrollment, to fulfill degree requirements.

The above requirement reflects the change that "Students doing the MENG degree programs or non-thesis MS degree program are no longer required to attend the seminar for graduation requirements." This change was approved by the MMAE faculty via a formal vote.

Before completion of the first semester of graduate study, full-time students should select 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 as well as the department's graduate studies committee and the department chair must approve this program. Students with the thesis option are required to pass an oral comprehensive examination on their 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.

Master of Science in Materials Science and Engineering (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(18)
Select a minimum of 18 credit hours from the Materials Science Courses below (p. 216)		18
Elective Courses		(14)
Select a minimum of 14 credit hours of 400-level and above MMAE courses ¹		14

¹ Students may include up to six credit hours of MMAE 594 Project for Master of Engineering Students.

Master of Science in Materials Science and Engineering (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	12
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(18)
Select a minimum of 18 credit hours from the Materials Science Courses below (p. 216)		18
Elective Courses		(6-8)
Select six to eight credit hours of 400-level and above MMAE courses ¹		6-8
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

¹ Students may include up to six credit hours of MMAE 594 Project for Master of Engineering Students.

Materials Science Courses

Code	Title	Credit Hours
MMAE 461	Failure Analysis	3
MMAE 470	Intro to Polymer Science	3
MMAE 472	Advanced Aerospace Materials	3

MMAE 501	Engineering Analysis I	3
MMAE 520	Advanced Thermodynamics	3
MMAE 533	Fatigue & Fracture Mechanisms	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 562	Design Modern Alloys	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 564	Dislocations/Strengthening Mec	3
MMAE 565	Materials Laboratory	3
MMAE 566	Pblms High Tempte Materials	3
MMAE 567	Fracture Mechanisms	3
MMAE 568	Diffusion	2
MMAE 569	Advanced Physical Metallurgy	3
MMAE 570	Computational Methods in MSE	3
MMAE 576	Materials Process Selection	3
MMAE 578	Fiber Composites	3
MMAE 579	Advanced Materials Processing	3

Master of Science in Mechanical and Aerospace Engineering

The master of science degree program advances knowledge through post-baccalaureate coursework. The program requires 32 credit hours. Students have the option of completing a thesis based on up to eight credit hours of research (MMAE 591) with the approval of a thesis adviser, or completing the program with courses, which may include up to six credit hours of projects (MMAE 594). In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with their adviser, in formulating an M.S. program. Registration and 80%-class session attendance—required for a passing grade—in the Seminar course MMAE 593 is required of all M.S. graduate students (Non-thesis or Thesis) and Ph.D. students. A satisfactory grade is required, in each semester of full-time enrollment, to fulfill degree requirements.

The above requirement reflects the change that "Students doing the MENG degree programs or non-thesis MS degree program are no longer required to attend the seminar for graduation requirements." This change was approved by the MMAE faculty via a formal vote.

Before completion of the first semester of graduate study, full-time students should select 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 as well as the department's graduate studies committee and the department chair must approve this program. Students with the thesis option are required to pass an oral comprehensive examination on their 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.

Master of Science in Mechanical and Aerospace Engineering (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Required Courses		(6-7)
MMAE 501	Engineering Analysis I	3
Select one core course in major area of study (see below)		3-4
Numerical Methods Elective		(3)
Select three credit hours from the following:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 500	Data Driven Modeling	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3

MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	3
Elective Courses		(22-23)
Select 22-23 credit hours of 400-level and above MMAE courses ¹		22-23

¹ Students may include up to six credit hours of MMAE 594 Project for Master of Engineering Students. Up to three credit hours of INTM courses may be used with adviser approval.

Master of Science in Mechanical and Aerospace Engineering (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
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 of 400-level and above MMAE courses		14-17
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

Core Courses as Determined by Major Area of Study

Code	Title	Credit Hours
Fluid Dynamics		(4)
MMAE 510	Fundmntls of Fluid Mechanics	4
Thermal Sciences		(3)
MMAE 520	Advanced Thermodynamics	3
or MMAE 525	Fundamentals of Heat Transfer	
Solids and Structures		(3)
MMAE 530	Advanced Mechanics Solids	3
Dynamics and Controls		(3)
MMAE 541	Advanced Dynamics	3
Computer Aided Design and Manufacturing		(3)
MMAE 545	Advanced CAD/CAM	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 choices.

The E3 specialization requires an interdisciplinary graduate project in an E3 area. 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 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 adviser, if the total undergraduate credit hours do not exceed departmental constraints. All full-time thesis students are required to register for MMAE 593 MMAE Seminar in every semester and achieve an attendance of greater than 80%.

Curriculum

Code	Title	Credit Hours
Core Courses		(15)
CHE 543	Energy Envir Economics	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	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	Renwble Enrgy Technologies	3
CHE 566	Electrochemical Engineering	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
Non-Core Courses		(9)
Select a minimum of two courses from the following:		6
MMAE 470	Intro to Polymer Science	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 566	Prblms High Tempte Materials	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	Physcheml Prcls in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcls Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Electives		(6)
Select a minimum of six credit hours of elective courses		6
Total Credit Hours		30

E3 Courses

See descriptions under the respective department's course listings.

Group A

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 choices.

The E3 specialization requires an interdisciplinary graduate project in an E3 area. 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 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 adviser, if the total undergraduate credit hours do not exceed departmental constraints. All full-time thesis students are required to register for MMAE 593 MMAE Seminar in every semester and achieve an attendance of greater than 80%.

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 Envir 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	Renwble Enrgy Technologies	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals 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	Conduction and Diffusion	3
MMAE 527	Heat Trnsf Convection Radiatio	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Enrgy Technologies	3
CHE 560	Ststcl Qlty Process Control	3
or MMAE 560	Ststcl Quality Procs Control	
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clnng	3
ENVE 580	Hazardous Waste Engineering	3
Electives		(6)
Select six credit hours		6
Total Credit Hours		30

E3 Courses

See descriptions under the respective department's course listings.

Group A

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 choices.

The E3 specialization requires an interdisciplinary graduate project in an E3 area. 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 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 adviser, if the total undergraduate credit hours do not exceed departmental constraints. All full-time thesis students are required to register for MMAE 593 MMAE Seminar in every semester and achieve an attendance of greater than 80%.

Curriculum

Code	Title	Credit Hours
Core Courses		(15)
CHE 543	Energy Envir Economics	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	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	Renwble Enrgy Technologies	3
CHE 566	Electrochemical Engineering	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
Non-Core Courses		(9)
Select a minimum of two courses from the following:		6
MMAE 470	Intro to Polymer Science	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 566	Prlms High Tempte Materials	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	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8
Electives		(0-2)
Select zero to two credit hours		0-2

Minimum degree credits required: 32

E3 Courses

See descriptions under the respective department's course listings.

Group A

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 choices.

The E3 specialization requires an interdisciplinary graduate project in an E3 area. 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 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 adviser, if the total undergraduate credit hours do not exceed departmental constraints. All full-time thesis students are required to register for MMAE 593 MMAE Seminar in every semester and achieve an attendance of greater than 80%.

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Engineering Analysis Courses		(3)
MMAE 501	Engineering Analysis I	3
Core Courses		(12)
CHE 543	Energy Envir Economics	3
Select a minimum of three credit hours from the following:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	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
MMAE 525	Fundamentals of Heat Transfer	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Engrg Technologies	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
MMAE 524	Fundamentals of Combustion	3
Non-Core Courses		(6)
Select a minimum of one course from the following:		3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Conduction and Diffusion	3
MMAE 527	Heat Trnsf Convection Radiatio	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Engrg Technologies	3
CHE/MMAE 560	Ststcl Qlty Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Elective Courses		(11)
Select a minimum of 11 credit hours of 400-level and above MMAE courses ¹		11

¹ Students may include up to six credit hours of MMAE 594 Project for Master of Engineering Students.

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Engineering Analysis Courses		(6)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Core Courses		(12)
CHE 543	Energy Envir Economics	3
Select a minimum of three credit hours from the following:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	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
MMAE 525	Fundamentals of Heat Transfer	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Enrgy Technologies	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
MMAE 524	Fundamentals of Combustion	3
Non-Core Courses		(6)
Select a minimum of one course from the following:		3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Conduction and Diffusion	3
MMAE 527	Heat Trnsf Convection Radiatio	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Enrgy Technologies	3
CHE/MMAE 560	Ststcl Qlty Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

E3 Courses

See descriptions under the respective department's course listings.

Group A

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 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 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. All full-time doctoral students are required to register for MMAE 593 MMAE Seminar in every semester and achieve an attendance of greater than 80%.

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, and the department chair. 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. The plan should also include MMAE 593 MMAE Seminar in every semester.

After students essentially complete all coursework, they 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 their thesis at a final oral examination, which is open to the public.

Curriculum

Code	Title	Credit Hours
Required Courses		(17-18)
Select a minimum of six courses from the following:		17-18
MMAE 461	Failure Analysis	3
MMAE 470	Intro to Polymer Science	3
MMAE 472	Advanced Aerospace Materials	3
MMAE 501	Engineering Analysis I	3
MMAE 520	Advanced Thermodynamics	3
MMAE 533	Fatigue & Fracture Mechanisms	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 562	Design Modern Alloys	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 564	Dislocations/Strengthening Mec	3
MMAE 565	Materials Laboratory	3
MMAE 566	Pblms High Tempte Materials	3
MMAE 567	Fracture Mechanisms	3
MMAE 568	Diffusion	2
MMAE 569	Advanced Physical Metallurgy	3
MMAE 570	Computational Methods in MSE	3
MMAE 576	Materials Process Selection	3
MMAE 578	Fiber Composites	3
MMAE 579	Advanced Materials Processing	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 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. All full-time doctoral students are required to register for MMAE 593 MMAE Seminar in every semester and achieve an attendance of greater than 80%.

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, and the department chair. 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. The plan should also include MMAE 593 MMAE Seminar in every semester.

After students essentially complete all coursework, they 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 their thesis at a final oral examination, which is open to the public.

Curriculum

For students entering with a B.S.:

Code	Title	Credit Hours
Required Courses		(27-29)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Select a minimum of two courses from group EA ¹		6
Select one core course in major area of study		3-4
Select one core course in second area		3-4
Select a minimum of nine credit hours of non-core courses in major area		9
Elective Courses		(7-21)
Select 7-21 credit hours		7-21
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.:

Code	Title	Credit Hours
Required Courses		(15-16)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Select a minimum of two courses from group EA ¹		6
Select 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

Code	Title	Credit Hours
Fluid Dynamics		(4)
MMAE 510	Fundmntls of Fluid Mechanics	4
Thermal Sciences		(3)
MMAE 520	Advanced Thermodynamics	3
or MMAE 525	Fundamentals of Heat Transfer	
Solids and Structures		(3)
MMAE 530	Advanced Mechanics Solids	3
Dynamics and Controls		(3)
MMAE 541	Advanced Dynamics	3
Computer Aided Design and Manufacturing		(3)
MMAE 545	Advanced CAD/CAM	3

¹Group EA

MMAE 509 is required for fluid dynamics, thermal sciences, and solids and structures students.

Code	Title	Credit Hours
MMAE 503	Advncd Engineering Analysis	3
MMAE 508	Perturbation Methods	3
MMAE 509	Intro to Continuum Mechanics	3
MATH 512	Partial Differential Equations	3
MATH 515	Ord Diff Eqtns&Dynamic Systems	3
MATH 522	Mathematical Modeling	3
MATH 535	Optimization I	3
MATH 544	Stochastic Dynamics	3
MATH 545	Stochastic Partial Diff Equatn	3
MATH 553	Discrete Applied Mathematics I	3
CHE 530	Advanced Process Control	3
ECE 505	Applied Optimization Engrgs	3
ECE 511	Analysis Random Signals	3
ECE 531	Linear System Theory	3
ECE 533	Robust Control	3
ECE 567	Statistical Signal Processing	3

Certificate in Computer Integrated Design and Manufacturing Curriculum

Code	Title	Credit Hours
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	Comp Intgrtd Manuf Technlgies	3
MMAE 557	Comp Intgrtd Manfctrng Systms	3
Total Credit Hours		12

Gainful Employment Disclosure for Certificate in Computer Integrated Design and Manufacturing

Certificate in Product Quality and Reliability Assurance Curriculum

Code	Title	Credit Hours
Required Courses		(12)
INTM 518	Industrial Risk Management	3
MMAE 560	Ststcl Quality Procs Control	3
MMAE 589	Apps in Reliability Engg I	3
MMAE 590	Apps Reliabilty Engineering II	3
Total Credit Hours		12

Gainful Employment Disclosure for Certificate in Product Quality and Reliability Assurance

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Dean

Anita K. Krug

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 technology in the teaching, practice, and public access to the law. The primary 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 Design, Law, and Technology

The Center for Design, Law & Technology (cDELTA or cD) promotes research, scholarship, and instruction at the intersection of creativity, technology, design, and the law. Building on the law school's recognized expertise, the center fosters research that examines a range of topics related to design, including the legal protections of design in the United States and internationally, creativity and innovation in design, and design thinking and problem-solving. Convening experts from various disciplines, including business, law, and design, the center hosts talks, workshops, and conferences related to these topics.

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.

Center on Socio-Legal Approaches to Property

The Center on Socio-Legal Approaches to Property engages in scholarship, public education, advocacy, and technical assistance around the question of how to defend the property rights of politically or economically vulnerable individuals or communities who have been unjustly dispossessed of their property.

Institute for Compliance in Financial Markets

The Institute for Compliance in Financial Markets 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. The Institute for Compliance offers a rich curriculum of classes. J.D. students who complete required coursework may obtain a Certificate in Financial Markets Compliance.

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 provides a forum to produce and disseminate knowledge on the social and legal implications of emerging technologies. As part of its mission, the institute sponsors long-term, multidisciplinary research; public conferences; judicial training; symposia for journalists; and other programs. Public programming, scholarship and research, and student educational opportunities in the institute focus on biotechnology, genetics, nanotechnology, internet privacy, app development, machine learning, and intellectual property. In addition, institute staff and faculty draft laws and regulations and develop other programs that guide public policy decisions.

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 seeks to showcase the significant intellectual contributions of Chicago-Kent's faculty and to give students the opportunity to learn more about the Court through participation in ISCOTUS events and projects. Other components of ISCOTUS are *ISCOTUSnow*, a blog devoted to informed, accessible discussion of the work of the Court, 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 Justice John Paul Stevens Jury Center serves as a center for the study of the jury. The Justice Stevens Jury Center has organized two conferences on the jury. One conference was on the American jury and was held at Chicago-Kent; the other was on juries across the globe and was held in Oñati, Spain. Both conferences resulted in publication of the conference papers. The Justice Stevens Jury Center has also organized numerous panels on the jury at different conferences, as well as several symposia on the jury, which have been published in the *Chicago-Kent Law Review*. The center also serves as a resource for members of the press who cover jury trials or jury issues and have jury-related questions.

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 design, and the ways in which innovation can lead to the more effective delivery of legal services.

Research and Training Facilities

Chicago-Kent College of Law Library

Chicago-Kent Law Library offers a comfortable library center for study and research with a skilled and friendly staff to support student academic life and faculty scholarship. Professional law librarians possess the expertise to provide research and reference assistance in all areas of law and legal technology training through in-class presentations, personal assistance, and instruction. Through the library's website, the law school community has remote access to a wide variety of database collections and electronic journals. The library offers extensive, multi-disciplinary print and electronic collections and connects students and faculty to an expanded array of materials through a statewide resource-sharing system and interlibrary loan. Library space includes a spacious reading room for independent study, group study rooms for collaborative work, and balconies for an outdoor study environment.

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; all 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, including student lounges, the computer lab, and even the 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 immerses students in 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 C-K Law Group, a teaching law firm 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, employment 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 standardized test scores, undergraduate records, personal statements, and their letters of recommendation.

All candidates must take either the LSAT or the GRE 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

Juris Doctor (J.D.) (p. 235)

Master of Laws (LL.M.) (p. 235)

Master of Taxation (p. 235)

Doctor of the Science of Law (J.S.D.) (p. 235)

Joint-Degree Programs

J.D./LL.M. in Financial Services Law (p. 235)

J.D./LL.M. in Taxation (p. 235)

With Stuart School of Business

J.D./M.B.A. (p. 236)

J.D./M.P.A. (p. 236)

J.D./M.S. in Environmental Management and Sustainability (p. 236)

J.D./M.S. in Finance (p. 236)

With University of Illinois at Chicago

J.D./Master of Public Health (M.P.H.) (p. 236)

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 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. Part-time students take a total of 22 credits in the first year. After the first year, part-time students normally take 8 to 13 credits per semester and can finish their degree requirements in four years, particularly if they take classes during one summer session. A selection of courses is offered each summer, mostly in the evening. First-year courses are required, but students participating in the 1L Your Way program may take approved upper-level electives or a clinic in the spring of their first year. 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 financial services law; international intellectual property law; legal innovation and technology; taxation; trial advocacy for international students; 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; legal innovation and technology; trial advocacy for international students; 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 and financial services law, which enable students to earn both degrees after seven semesters of full-time residence, instead of eight.

Master of Taxation

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 Financial Services Law

Deregulation of financial services, development of financial derivatives, reform of taxation, regulation of specific risks in the wake of the Crisis of 2008, and deployment of new technologies have created an environment in which attorneys and other professionals must broaden their knowledge and sharpen their analytical skills in understanding the integrated financial services markets. 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, to deepen their knowledge of particular topics of interest, and to enhance their skills as professionals. Courses are offered on weekday evenings.

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./Master of Business Administration (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 Environmental Management and Sustainability

The law school offers a joint J.D./M.S. in Environmental Management and Sustainability degree program in conjunction with Stuart School of Business. The Environmental Management and Sustainability 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.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./Master of Public Administration (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 (p. 236)
- Criminal Litigation (p. 237)
- Environmental and Energy Law (p. 237)
- Financial Markets Compliance (p. 237)
- Intellectual Property Law (p. 237)
- International and Comparative Law (p. 237)
- Labor and Employment Law (p. 237)
- Litigation and Alternative Dispute Resolution (p. 237)
- Litigation and Alternative Dispute Resolution and Labor and Employment Law (Joint Program) (p. 238)
- Praxis Program (p. 238)
- Public Interest Law (p. 238)

Business Law

The J.D. Certificate Program in Business Law 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, taxation, secured transactions, and bankruptcy. 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 J.D. Certificate 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 C-K Law Group, the law school's in-house teaching law firm.

Environmental and Energy Law

The J.D. Certificate 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. The program includes a clinic, environmental law externships, a journal, and a moot court team.

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.

Financial Markets Compliance

Chicago-Kent's J.D. Certificate Program in Financial Markets Compliance, one of the first of its kind in an American law school, provides students with substantive knowledge of financial markets compliance and signals to employers a student's interest in the field. The program offers a rich curriculum in financial markets regulation, including classes in securities, commodities, and banking regulation, along with its capstone compliance course. The Certificate in Financial Markets Compliance requires a minimum of 16 credit hours in the field and exposes students to all of the most important aspects of compliance.

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, trademarks, trade secrets, and design protection. As part of the J.D. Certificate Program in Intellectual Property Law's rigorous training, students obtain a firm foundation in three required substantive courses of intellectual property law—copyright, patents, and trademarks—and can choose from numerous electives in their studies of intellectual property, such as design law, entertainment law, and international intellectual property. Students also develop the practical skills needed for today's competitive legal market. IP certificate candidates participate in the Practice Experience, which involves real-world practice in the IP field with actual or simulated cases, applying the IP law knowledge they learned in previous coursework. The Practice Experience includes courses taught by experienced attorneys at law firms, such as the IP Clinic, IP Strategies, IP Trial Advocacy, IP externships, and patent litigation courses, as well as moot court competitions in which Chicago-Kent teams have consistently placed in national competitions. The IP program encourages scholarship and discourse among academics, practitioners, and students with events such as the Chicago Intellectual Property Colloquium and the annual Supreme Court IP Review. Students complete 20 credit hours of approved coursework.

International and Comparative Law

In a climate of continuous change, Chicago-Kent's J.D. Certificate 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 potential 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 two-credit seminar.

Labor and Employment Law

The J.D. Certificate 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 J.D. Certificate 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 C-K Law Group, 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.

Litigation and Alternative Dispute Resolution and Labor and Employment Law (Joint Program)

The joint J.D. Certificate Program in Litigation and Alternative Dispute Resolution and Labor and Employment Law is designed for students who want to market themselves to potential employers as well-versed in the highly complementary areas of litigation, alternative dispute resolution (ADR), and labor and employment law. To complete the certificate, students must take seven core courses in labor and employment law, litigation and ADR, plus two approved electives.

Praxis Program

The Praxis J.D. Certificate Program is designed for students who wish to prepare for practice with a truly experiential course of study. The curriculum guides participants through an individualized program designed to provide exposure to the core competencies required of successful lawyers. After all, how can a student learn to practice law without ever practicing their skills? Participating students must complete 24 credit hours of experiential or skills-based coursework (including a clinic or externship and the course Practice and Professionalism); undertake a series of self-assessments designed to measure progress in skill development; create a professional online profile; and attend a series of professional development workshops. Students enrolled in the Praxis Program may concurrently enroll in an additional, subject-matter certificate program offered by Chicago-Kent.

Public Interest Law

The J.D. Certificate Program in Public Interest Law builds on Chicago-Kent's strong public interest tradition and adds 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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Rahman Azari

Director of Landscape Architecture and Urbanism Program

Ron Henderson

Director of Master of Architecture Program

Martin Felsen

Director of Master of Science in Architecture Program

Rahman Azari

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 six-year, three-year, or two-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 eight-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 six-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 outfitted with the latest architectural digital design and fabrication software. All labs and requisite software are listed here: [iit.edu/ots/computer labs.shtml](http://iit.edu/ots/computer%20labs.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.

Advanced Studio

"Advanced 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.

"Advanced Studio" is a 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
Application fee of \$60
Portfolio
Two letters of recommendation
Statement of intent
Official transcripts

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

292 (quantitative + verbal), 2.5 analytical writing

Minimum TOEFL Scores

90/600 (internet-based/paper-based test scores)

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. 251)
- Master of High Performance Buildings (p. 255)
- Master of Landscape Architecture (M.L.A.), Professional Degree (p. 256)
- Master of Architecture/Master of Landscape Architecture (dual degree) (p. 260)
- Master of Science in Architecture (p. 266)
- Doctor of Philosophy in Architecture (p. 267)
- Doctor of Philosophy in Architecture with Specialization in History and Theory of Architecture (p. 268)
- Doctor of Philosophy in Architecture with Specialization in Technologies of the Built Environment (p. 269)

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.

Prerequisite(s): ARCH 500 with min. grade of C

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.

Prerequisite(s): ARCH 506 with min. grade of C and ARCH 542 with min. grade of C and ARCH 541 with min. grade of C and ARCH 507 with min. grade of C

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: 1 Lab: 2 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 with min. grade of C

Lecture: 1 Lab: 2 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 with min. grade of C

Lecture: 1 Lab: 2 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**Environment and Building Systems 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**Environment and Building Systems 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 with min. grade of C

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: 1 Credits: 3

ARCH 541**Architecture Studio I: Elements**

The design studio focuses on the tools, techniques, methods, and methodologies of architectural design. The studio investigates the articulation of space, tectonic assembly, and human behavior as critical foundations of the making of the built environment. The studio focuses on developing core drawing, making, thinking, and communication skills via a series of discrete projects that aggregate into a comprehensive body of work. Analytical investigation of the techniques and methods of architectural design and representation are interwoven with an analytical investigation of site, place, inhabitation, and elemental spatial archetypes. The studio is largely comprised of two primary projects (Composite City and Inhabited Archetypes), with specific internal phases and deliverables, structured to operate as a complementary whole. Composite City comprises a series of studies in drawing, modeling and making that dissect the layers, components and phenomena of the built environment, via questions of narrative, memory, space, tectonics, systems and compositions. Inhabited Archetypes comprises a series of spatial explorations that employ the preceding analyses as sites of operation. Four archetypes (bridge, tower, wall, stair) prompt fundamental questions of architectural space (tectonics and inhabitation) and design processes. Working iteratively and comparatively, each archetype will be a medium to investigate issues of structure, skin, thickness, thinness, material, assembly, inhabitation and narrative. The semester culminates with the process of assembling student portfolios.

Lecture: 0 Lab: 12 Credits: 6

ARCH 542**Architecture Studio II: Architecture in the City**

The second semester of the Master of Architecture focuses on the development of the fundamental aspects of form, space, structure, and materiality explored through the design of a small neighborhood library, which is an essential building-block of the city. The design-based investigation focuses on the study of spatial organization, public space, user experiences and basic tectonic principles, as well as examining the arrangement of and relations between the parts and elements of the urban environment. Through a series of assignments, students are guided step by step through the design process. The first part of the semester focuses on understanding the project's context through the careful investigation of current issues, historical and contemporary precedents, and an in-depth analysis and documentation of a particular site within a specific neighborhood in Chicago. This process is followed by forecasting, conceptual framing, and schematic explorations, and culminates with the strategic development and conceptual detailing of a building and its environs. Design projects are developed individually with the support of team research. A strong emphasis is placed on craft, making, the communication of ideas, and documentation of process. The semester culminates by assembling student portfolios of design work.

Prerequisite(s): ARCH 541 with min. grade of C

Lecture: 0 Lab: 12 Credits: 6

ARCH 543**Architecture Studio III: Living in the City**

The design studio focuses on the design and structural engineering of high-volume residential buildings, or "housing." The design of housing in cities such as Chicago is a story of bold experimentation and innovation, but also contradictions and controversy. Chicago has been at the forefront of developing new types of public and private housing and design strategies to improve and maintain public health since the city's founding in the mid 19th century. Students are exposed to a variety of housing and hybrid buildings, and undertake research projects in select cities around the world to compare and contrast a variety of issues such as: density, dwelling unit types, mixed use programming, materiality, development models, cultural norms, and relationships between functionality and luxury. The studio is structured around three primary assignments beginning with research and drawing assignments of housing types in Chicago, followed by analyses of dense, urban housing projects in global cities, to the final design project. The studio's principle concern is giving form, shape, and character to collectively inhabited high-rise buildings, and to the streets and public spaces that surround them. Several lectures, presentations and field trips throughout the semester highlight discernable and meaningful connections between people and places, movement and morphology, natural resources and the artificial fabric of the city. A particular focus is on place-making, environmental stewardship, social equity, and economic vitality of urban neighborhoods. The studio operates as a laboratory in which to explore new possibilities for urban living in Chicago, specifically within a selected neighborhood and project site.

Prerequisite(s): ARCH 542 with min. grade of C

Lecture: 0 Lab: 12 Credits: 6

ARCH 544**Architecture Studio IV: Working in the City**

The design studio focuses on the design of urban industrial architecture. Industrial buildings house large number of workers operating complex, high-tech machinery and equipment. Industrial buildings have gradually become a vital part of the architecture of the 21st century. Thanks to the constant advancement of non-polluting micro-technologies, industrial buildings are emerging in the center of service-oriented cities around the globe. The first part of the semester focuses on understanding the typology of industrial buildings through the careful investigation of current workplace issues, historical and contemporary precedents, and an in-depth analysis and documentation of a particular site within a specific neighborhood in the city of Chicago. The second part of the studio focuses on aesthetic qualities of industrial architecture, and design issues related to: building facades and layered skins; proportioning and division of large volumes of enclosed space; harmony of structural and internal spatial elements; orderly placement of people, machinery and equipment; and, systematic arrangement of logistical operations to and from the project site. Emphasis is placed on the environmental sustainability of the building design approach and execution. Special attention is given to material/spatial efficiency, mechanical system selection and envelope design. Students are encouraged to evaluate and provide proof-of-concept data for decisions pertaining to energy use and efficiency, recycling and the reuse of natural resources.

Prerequisite(s): ARCH 543 with min. grade of C

Lecture: 0 Lab: 12 Credits: 6

ARCH 545**Architecture Studio V: Advanced**

Advanced Studios engage both IIT architecture faculty and a select group of visiting studio professors noted for their outstanding professional experience in contemporary practice. The focus of each studio is strong design experimentation that is implemented in highly resolved, complex architectural design projects. Studios work on sites within Chicago, explore urban areas around the globe, and/or focus on hypothetical or technological challenges that shape the built environment. Students design structural and material systems that recognize issues of ecology as well as the broader, integrated concerns of climate, energy and natural resource use, and sustainability. Uniting the diverse strands of urban place making, economic diversity, social equity and environmental stewardship, Advanced Studios promote the design of places that reflect the values of their inhabitants, and create a lasting sense of community with meaningful identity. The studios are formed in thematic clusters that complement each other or serve as dialectical opposites. Each studio explores a variety of techniques from parametric design, digital fabrication, model making, and advanced geospatial software to cultural and theoretical explorations. Students will be able to select from a variety of studio topics. The vertical studio integrates advanced BArch, MArch, MS, and PHD students. Open only to Architecture majors.

Prerequisite(s): ARCH 544 with min. grade of C

Lecture: 0 Lab: 12 Credits: 6

ARCH 546**Architecture Studio VI: Advanced**

The aim of the design studio is to develop formal solutions which address the complexities of modern metropolis and advance disciplinary knowledge at large. The Advanced Studio program provides the intellectual climate as well as material infrastructure to explore the larger forces that influence the growth of cities. In the contemporary world, developing alternative models of design are necessary to make a transformative impact on the built environment. Design work in Advanced Studios at IIT directly engages real-life challenges and design-based solutions. As they seek to synthesize and impart principles and knowledge, to advance aesthetic and analytical skills, and to creatively expand upon given cultural norms, the Advanced Studios offer students the means to leverage their intuitions and insights to find better ways to enhance the built environment. The studios are formed in thematic clusters that complement each other or serve as dialectical opposites. Each studio explores a variety of techniques from parametric design, digital fabrication, model making, and advanced geospatial software to cultural and theoretical explorations. The vertical studio integrates advanced BArch, MArch, MS, and PHD students. Open only to Architecture majors.

Prerequisite(s): ARCH 545 with min. grade of C

Lecture: 0 Lab: 12 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 569**Good Design and Good Business**

From our very own experience, architects with ambitious design agendas have a tendency to focus on design at the expense of paying attention to and designing their businesses. Awareness of a more integrated and balanced approach is essential for young architects as they navigate a rapidly changing world and will help them develop tools and skills to implement, at varying scales, their ideas of a better metropolis. Specifically, the seminar will touch upon such topics as decision making, communication and presentation skills, multidisciplinary collaboration, persuasion and negotiation, and professional advocacy. Pedagogically, the seminar will consist of lectures, case studies, readings, and practice assignments.

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: 3 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: 3 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 M.S.**

Development of an advanced, research-based thesis as required for the M.S. in Arch. degree.

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 with min. grade of C

Lecture: 0 Lab: 12 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. Students will be required to produce weekly writing assignments based on publications provided ahead of time by guest speakers.

Lecture: 1 Lab: 0 Credits: 1

ARCH 596**ARCH IPRO**

Lecture: 0 Lab: 3 Credits: 3

ARCH 597**Special Problems****Credit:** Variable**ARCH 600****Continuance of Residence****Lecture:** 0 **Lab:** 1 **Credits:** 1**ARCH 601****Research Methodologies**

This course provides a foundation for advanced 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 architectural research. It is intended to provide substantial information on advanced research methodologies. 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 with min. grade of C**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:** 3 **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:** 3 **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.

Credit: Variable**ARCH 691****Doctoral Research****Credit:** Variable**ARCH 801****Introduction to Architecture: Graduate Architectural 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**ARCH 999****Architecture Elective(s)****Credit:** Variable**LA 501****History, Theory, and Criticism I: Landscape Architecture Theory**

Inquiry of natural factors and ecology (soil formations, geological features, hydrological patterns, catastrophic events, etc.) in the settlement and development of cities. The work of the seminar will include an inventory of these factors in selected global cities, including Chicago, and their influence on urban design and site-specific landscape architecture 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 with min. grade of C

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 with min. grade of C and LA 526 with min. grade of C

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: 12 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 with min. grade of C

Lecture: 0 Lab: 12 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 with min. grade of C or LA 543 with min. grade of C

Lecture: 0 Lab: 12 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 with min. grade of C

Lecture: 0 Lab: 12 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 with min. grade of C

Lecture: 0 Lab: 12 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

LA 999**Landscape Arch Elective(s)**

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 Illinois Tech'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 Illinois Tech'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.

Master of Architecture

Code	Title	Credit Hours
Required Courses		(72)
ARCH 485	Structures I	3
ARCH 486	Structures II	3
ARCH 500	Global Modernism	3
ARCH 501	Contemporary Architecture	3
ARCH 505	Urban Ecology	3
ARCH 506	Design Communications I	3
ARCH 507	Design Communications II	3
ARCH 508	Design Communications III	3
ARCH 513	Environ & Building Systems I	3
ARCH 514	Environ & Building Systems II	3
ARCH 520	Introduction to Urbanism	3
ARCH 541	Architecture Studio I	6
ARCH 542	Architecture Studio II	6
ARCH 543	Architecture Studio III	6
ARCH 544	Architecture Studio IV	6
ARCH 545	Architecture Cloud Studio V	6
ARCH 546	Architecture Cloud Studio VI	6
ARCH 568	Architectural Practice	3
Architectural History Electives		(6)
Select a minimum of six credit hours from the following: ¹		6
ARCH 502	Adv Topics in Hist&Theory I	3
ARCH 503	Adv Topics in Hist&Theory II	3
Materials Elective		(3)
Select a minimum of three credit hours from the following:		3
ARCH 480	Materials and Construction	3
ARCH 482	Material: Fibrous	3
ARCH 483	Material: Transparent	3
ARCH 509	Topics in Advanced Technology	3
Electives		(21)
Select a minimum of 21 credit hours of architecture electives.		21
Total Credit Hours		102

¹ ARCH 502 and ARCH 503 may be taken multiple times.

Master of Architecture with Advanced Standing

Code	Title	Credit Hours
Required Courses		(54)
ARCH 485	Structures I	3
ARCH 486	Structures II	3
ARCH 500	Global Modernism	3
ARCH 501	Contemporary Architecture	3
ARCH 502	Adv Topics in Hist&Theory I	3
or ARCH 503	Adv Topics in Hist&Theory II	
ARCH 508	Design Communications III	3
ARCH 513	Environ & Building Systems I	3
ARCH 514	Environ & Building Systems II	3
ARCH 520	Introduction to Urbanism	3
ARCH 543	Architecture Studio III	6
ARCH 544	Architecture Studio IV	6
ARCH 545	Architecture Cloud Studio V	6
ARCH 546	Architecture Cloud Studio VI	6
ARCH 568	Architectural Practice	3
Electives		(12)
Select a minimum of 12 credit hours of architecture electives.		12
Total Credit Hours		66

Master of Architecture 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 508	3	ARCH 502 or 503	3
ARCH 513	3	ARCH 505	3
ARCH 520	3	ARCH 514	3
ARCH 543	6	ARCH 544	6
Materials Elective ¹	3	ARCH 568	3
	18		18
		Year 3	
Semester 1	Credit Hours	Semester 2	Credit Hours
ARCH 545	6	ARCH 546	6
ARCH 502 or 503	3	Architecture Elective	3
Architecture Elective	3	Architecture Elective	3
Architecture Elective	3	Architecture Elective	3
Architecture Elective	3		
	18		15

Total Credit Hours: 102

¹ Choose one of ARCH 480, ARCH 482, ARCH 483, or ARCH 509.

Master of Architecture 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
Architecture Elective	3	Architecture Elective	3
Architecture Elective	3	Architecture Elective	3
15		15	
Total Credit Hours: 66			

Master of High Performance Buildings

The post-professional Master of High Performance Buildings is an academic degree, offered jointly by the College of Architecture and the Department of Civil, Architectural, and Environmental Engineering. It is intended for students, with professional degrees in architecture or a bachelor of science degree in engineering, seeking to develop a better understanding of the theories, methods, and technologies necessary to achieve high performance, energy efficient, healthy, and sustainable buildings, with an emphasis on the integrated design process in which architects and engineers work together to achieve common goals.

Admission Requirements

Minimum GRE requirements: 292 quantitative + verbal and 2.5 analytical writing.

Code	Title	Credit Hours
Required Courses		(15)
CAE 513	Building Science	3
CAE 556	Net Zero Energy Home Dsgn I	3
CAE 557	Net Zero Energy Home Dsgn II	3
ARCH 546	Arch Studio VI: Advanced	6
Elective Courses		(15)
Select a minimum 15 credit hours from the following: ¹		15
ARCH 483	Material: Transparent	3
ARCH 502	Adv Topics in Hist&Theory I	3
ARCH 509	Topics in Advanced Technology	3
ARCH 513	Environ & Building Systems I	3
ARCH 514	Environ & Building Systems II	3
ARCH 551	Desn Energy-Efficient Bldg I	3
ARCH 552	Design of Energy-Eff Bldg II	3
ARCH 597	Special Problems	1-8
CAE 466	Building Electrical/Lighting	3
CAE 467	Lighting Systems Design	3
CAE 470	Constrctn Methods&Cost Estmg	3
CAE 515	BIM Applications for Bldg Perf	3
CAE 524	Building Enclosure Design	3
CAE 526	Energy Conservation Dsgn:Bldgs	3

CAE 550	Applied Bldg Energy Modeling	3
EG 430	Intro Building Info Modeling	3
ENVE 576	Indoor Air Pollution	3
Total Credit Hours		30

¹ Maximum 12 credit hours from 400 level elective courses allowed.

Master of Landscape Architecture

The Master of Landscape Architecture + Urbanism Program at Illinois Institute of Technology is a unique program in the United States in that we are a landscape architecture program in an urban private university. Our curriculum amplifies this urban context with courses that investigate complex landscape problems of the twenty-first century metropolis: the urban design implications of driverless cars, post-industrial sites, water quality and management, technological innovation, social equity, rapid urbanization, climate change, and a vital and open public realm, among others. More than ever, the world needs more informed, more innovative, more critically involved landscape architects—individuals who have emerged among design professionals to lead in the reclamation, organization, and understanding of our cities to meet these 21st century challenges.

Chicago is a unique metropolis to investigate the potential of urban landscapes. It 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, it is 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

Code	Title	Credit Hours
Required Courses		(75)
LA 501	History/Theory/Criticism I	3
LA 502	History/Theory/Criticism II	3
LA 503	History/Theory/Criticism IV	3
LA 504	History/Theory/Criticism III	3
LA 514	Prof Practice of Land Arch I	3
LA 516	Prof Practice of Land Arch II	3
LA 525	Design Media I	3
LA 526	Design Media II	3
LA 527	Design Media III	3
LA 541	Landscape Arch Studio I	6
LA 542	Landscape Arch Studio II	6
LA 543	Landscape Arch Studio III	6
LA 544	Landscape Arch Studio IV	6
LA 545	Landscape Arch Studio V	6
LA 546	Landscape Arch Studio VI	6
LA 565	Ecology & Materials Wksp I	3
LA 566	Ecology & Materials Wksp II	3
LA 567	Ecology & Materials Wksp III	3
LA 568	Ecology & Materials Wksp IV	3
Elective Courses		(15)
Select six credit hours of Landscape Architecture electives ¹		6
Select nine 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

Code	Title	Credit Hours
Required Courses		(48)
LA 501	History/Theory/Criticism I	3
LA 503	History/Theory/Criticism IV	3
LA 504	History/Theory/Criticism III	3
LA 516	Prof Practice of Land Arch II	3
LA 525	Design Media I	3
LA 541	Landscape Arch Studio I	6
LA 542	Landscape Arch Studio II	6
LA 545	Landscape Arch Studio V	6
LA 546	Landscape Arch Studio VI	6
LA 565	Ecology & Materials Wksp I ¹	3
LA 567	Ecology & Materials Wksp III ¹	3
LA 568	Ecology & Materials Wksp IV	3
Elective Courses		(12)
Select three credit hours of Landscape Architecture electives ²		3
Select nine 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 542	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 504	3	LA 546	6
LA 516	3	Landscape Architecture Elective ³	3
LA 545	6	Landscape Architecture/Architecture Elective ²	3
LA 567 ¹	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 Architecture/Master of Landscape 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 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 Architecture and Master of Landscape Architecture degrees together, we embrace the integrative thinking that will address the challenges and opportunities set before designers of the 21st century.

Admission Requirements

To be admitted without conditions to the M.Arch./M.L.A. 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 Illinois Tech'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 course equivalent to Illinois Tech'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. prior college-level coursework in freehand drawing, biology, and earth science (geology, physical geography, or hydrology, etc.)
6. a minimum of 45 semester hours (or the quarter hour equivalent) outside of architectural studies, either as general studies or electives with content outside of architecture

Candidates admitted with deficiencies in any of these prerequisites must fulfill them before matriculation. 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. Applicants must have a college grade point average of 3.0 on a 4.0 scale.

Candidates who hold a B.S. in Architecture, a B.S. in Landscape Architecture (B.S.L.A.), or an equivalent pre-professional architecture degree, that partially fulfills NAAB (National Architectural Accreditation Board) requirements may qualify for up to one year of advanced standing in the professional degree program. For applicants with undergraduate degrees in architecture, the portfolio is the single most important component of the application. Project selection should be heavily skewed towards large-scale comprehensive design projects developed across several scales. Mastery of structural design, familiarity with advanced building technologies, and thorough knowledge of building practices should be clearly communicated.

Master of Architecture/Master of Landscape Architecture

Code	Title	Credit Hours
Required Courses		(11)
ARCH 485	Structures I	3
ARCH 486	Structures II	3
ARCH 500	Global Modernism	3
ARCH 501	Contemporary Architecture	3
ARCH 502	Adv Topics in Hist&Theory I	3
ARCH 506	Design Communications I	3
ARCH 507	Design Communications II	3
ARCH 513	Environ & Building Systems I	3
ARCH 514	Environ & Building Systems II	3
ARCH 520	Introduction to Urbanism	3
ARCH 541	Architecture Studio I	6
ARCH 542	Architecture Studio II	6
ARCH 543	Architecture Studio III	6
ARCH 544	Architecture Studio IV	6
LA 501	History/Theory/Criticism I	3
LA 502	History/Theory/Criticism II	3
LA 503	History/Theory/Criticism IV	3
LA 504	History/Theory/Criticism III	3
LA 514	Prof Practice of Land Arch I	3
or ARCH 568	Architectural Practice	
LA 516	Prof Practice of Land Arch II	3
LA 527	Design Media III	3
LA 541	Landscape Arch Studio I	6
LA 542	Landscape Arch Studio II	6
LA 543	Landscape Arch Studio III	6
LA 546	Landscape Arch Studio VI	6
or ARCH 546	Architecture Cloud Studio VI	
LA 565	Ecology & Materials Wksp I	3
LA 566	Ecology & Materials Wksp II	3
LA 567	Ecology & Materials Wksp III	3
LA 568	Ecology & Materials Wksp IV	3
Architecture Electives		(6)
Choose a minimum of six credit hours from any ARCH 400- or 500-level course with adviser approval.		6
Landscape Architecture Electives		(6)
Choose a minimum of six credit hours from any LA 400- or 500-level course with adviser approval.		6
LA or ARCH Electives		(6)
Choose a minimum of six credit hours from any LA or ARCH 400- or 500-level course with adviser approval.		6
Total Credit Hours		129

Master of Architecture/Master of Landscape Architecture with Advanced Standing (admitted with a Bachelor in Landscape Architecture)

Code	Title	Credit Hours
Required Courses		(81)
ARCH 485	Structures I	3
ARCH 486	Structures II	3
ARCH 500	Global Modernism	3
ARCH 501	Contemporary Architecture	3
ARCH 502	Adv Topics in Hist&Theory I	3
or ARCH 503	Adv Topics in Hist&Theory II	
ARCH 513	Environ & Building Systems I	3
ARCH 514	Environ & Building Systems II	3
ARCH 520	Introduction to Urbanism	3
ARCH 542	Architecture Studio II	6
or LA 542	Landscape Arch Studio II	
ARCH 543	Architecture Studio III	6
ARCH 544	Architecture Studio IV	6
ARCH 546	Architecture Cloud Studio VI	6
or LA 546	Landscape Arch Studio VI	
LA 501	History/Theory/Criticism I	3
LA 503	History/Theory/Criticism IV	3
LA 504	History/Theory/Criticism III	3
LA 514	Prof Practice of Land Arch I	3
or ARCH 568	Architectural Practice	
LA 516	Prof Practice of Land Arch II	3
LA 541	Landscape Arch Studio I	6
LA 545	Landscape Arch Studio V	6
LA 567	Ecology & Materials Wksp III	3
LA 568	Ecology & Materials Wksp IV	3
Architecture or Landscape Architecture Design Communication Elective		(3)
ARCH 508	Design Communications III	3
or LA 527	Design Media III	
LA or ARCH Electives		(15)
Choose a minimum of 15 credit hours from any LA or ARCH 400- or 500-level course with adviser approval.		15
Total Credit Hours		99

Master of Architecture/Master of Landscape Architecture with Advanced Standing (admitted with a B.A. or B.S. in Architecture)

Code	Title	Credit Hours
Required Courses		(87)
ARCH 485	Structures I	3
ARCH 486	Structures II	3
ARCH 501	Contemporary Architecture	3
ARCH 502	Adv Topics in Hist&Theory I	3
or ARCH 503	Adv Topics in Hist&Theory II	
ARCH 513	Environ & Building Systems I	3
ARCH 514	Environ & Building Systems II	3
ARCH 520	Introduction to Urbanism	3
ARCH 543	Architecture Studio III	6
ARCH 544	Architecture Studio IV	6
ARCH 546	Architecture Cloud Studio VI	6
or LA 546	Landscape Arch Studio VI	
LA 501	History/Theory/Criticism I	3
LA 502	History/Theory/Criticism II	3
LA 503	History/Theory/Criticism IV	3
LA 504	History/Theory/Criticism III	3
LA 514	Prof Practice of Land Arch I	3
or ARCH 568	Architectural Practice	
LA 516	Prof Practice of Land Arch II	3
LA 541	Landscape Arch Studio I	6
LA 542	Landscape Arch Studio II	6
LA 543	Landscape Arch Studio III	6
LA 565	Ecology & Materials Wksp I	3
LA 566	Ecology & Materials Wksp II	3
LA 567	Ecology & Materials Wksp III	3
LA 568	Ecology & Materials Wksp IV	3
Architecture or Landscape Architecture Design Communication Elective		(3)
ARCH 508	Design Communications III	3
or LA 527	Design Media III	
Architecture Elective		(3)
Choose a minimum of three credit hours from any ARCH 400- or 500-level course with adviser approval.		3
Landscape Architecture Elective		(3)
Choose a minimum of three credit hours from any LA 400- or 500-level course with adviser approval.		3
LA or ARCH Electives		(3)
Choose a minimum of three credit hours from any LA or ARCH 400- or 500-level course with adviser approval.		3
Total Credit Hours		99

Master of Architecture/Master of Landscape Architecture Curriculum

				Year 1
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 500	3	ARCH 486	3	
ARCH 541	6	ARCH 507	3	
ARCH 485	3	ARCH 542	6	
ARCH 506	3	LA 502	3	
		LA 566	3	
	15		18	
				Year 2
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 513	3	ARCH 501	3	
ARCH 543	6	ARCH 514	3	
LA 501	3	ARCH 544	6	
LA 565	3	LA 568	3	
	15		15	
				Year 3
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 520	3	LA 503	3	
LA 504	3	LA 514 or ARCH 568	3	
LA 527	3	LA 542	6	
LA 541	6	Architecture or Landscape Architecture Elective ¹	3	
LA 567	3			
	18		15	
				Year 4
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 502 or 503	3	LA 516	3	
LA 543	6	LA 546 or ARCH 546	6	
Architecture Elective ²	3	Architecture Elective ²	3	
Landscape Architecture Elective ³	3	Landscape Architecture Elective ³	3	
Architecture or Landscape Architecture Elective ¹	3			
	18		15	

Total Credit Hours: 129

¹ Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval.

² Electives may be chosen from any ARCH 400- or 500-level course with adviser approval.

³ Electives may be chosen from any LA 400- or 500-level course with adviser approval.

Master of Architecture/Master of Landscape Architecture with Advanced Standing Curriculum (admitted with a Bachelor in Landscape Architecture)

Year 1

Semester 1	Credit Hours	Semester 2	Credit Hours
ARCH 500	3	ARCH 501	3
LA 501	3	ARCH 542 or LA 542	6
LA 541	6	LA 568	3
LA 567	3	Architecture/Landscape Architecture Design Communication Elective ¹	3
		Architecture or Landscape Architecture Elective ²	3
	15		18

Year 2

Semester 1	Credit Hours	Semester 2	Credit Hours
ARCH 485	3	ARCH 486	3
ARCH 513	3	ARCH 514	3
ARCH 543	6	ARCH 544	6
Architecture or Landscape Architecture Elective ²	3	LA 503	3
		LA 514 or ARCH 568	3
	15		18

Year 3

Semester 1	Credit Hours	Semester 2	Credit Hours
ARCH 520	3	ARCH 502 or 503	3
LA 504	3	ARCH 546 or LA 546	6
LA 516	3	Architecture or Landscape Architecture Elective ²	3
LA 545	6	Architecture or Landscape Architecture Elective ²	3
Architecture or Landscape Architecture Elective ²	3		
	18		15

Total Credit Hours: 99

¹ Choose from ARCH 508 or LA 527.

² Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval.

Master of Architecture/Master of Landscape Architecture with Advanced Standing Curriculum (admitted with a B.A. or B.S. in Architecture)

				Year 1
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 513	3	ARCH 501	3	
LA 501	3	ARCH 514	3	
LA 541	6	LA 502	3	
LA 565	3	LA 542	6	
		LA 566	3	
	15		18	
				Year 2
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 485	3	ARCH 486	3	
ARCH 502 or 503	3	ARCH 544	6	
ARCH 543	6	LA 514 or ARCH 568	3	
LA 567	3	LA 568	3	
		Architecture/Landscape Architecture Design Communication Elective ¹	3	
	15		18	
				Year 3
Semester 1	Credit Hours	Semester 2	Credit Hours	
ARCH 520	3	ARCH 546 or LA 546	6	
LA 504	3	LA 503	3	
LA 516	3	Architecture Elective ³	3	
LA 543	6	Architecture or Landscape Architecture Elective ⁴	3	
Landscape Architecture Elective ²	3			
	18		15	

Total Credit Hours: 99

¹ Choose from ARCH 508 or LA 527.

² Electives may be chosen from any LA 400- or 500-level course with adviser approval.

³ Electives may be chosen from any ARCH 400- or 500-level course with adviser approval.

⁴ Electives may be chosen from any LA or ARCH 400- or 500-level course with adviser approval.

Master of Science in Architecture - Post-Professional Degree

The Master of Science in Architecture is a research-oriented post-professional degree program that allows students to pursue advanced individual studies that bridge design and research. Topics are determined by the research interests of our faculty and include urbanism, design methods, structural systems, energy-based design, fabrication, and landscape architecture. Student research culminates in a thesis.

Admission and Curriculum Requirements

The program is open to applicants holding an accredited professional degree in architecture, landscape architecture, urban design, or allied field. Applicants with a degree earned outside the U.S. must have the equivalent to a first professional degree and be eligible for licensure in their home country.

The Master of Science in Architecture is a three semester program (this may include one summer semester). The program of study requires a minimum of 32 credit hours, selected from advanced studios, lectures, and seminars. Working with a thesis adviser, each student should develop a detailed thesis proposal, which must be approved by the adviser and by the director of the program. The final thesis must be approved by the student's advisory committee and be submitted to the university library.

Code	Title	Credit Hours
Required Courses		(3)
ARCH 601	Research Methodologies	3
Thesis Research		(8)
ARCH 591	Research and Thesis M.S.	8
Elective Courses		(21)
Select 21 credit hours from 400-level or above ARCH, AURB, or LA courses. ¹		21
Total Credit Hours		32

¹ Electives may include up to two studio courses (typically six credits each). 400-level and above courses from other departments may be used subject to adviser approval.

Curriculum

					Year 1
Semester 1	Credit Hours	Semester 2	Credit Hours	Summer	Credit Hours
ARCH 601		3 ARCH 591		3 ARCH 591	5
Architecture Elective		3 Architecture Elective		3	
Architecture Elective		3 Architecture Elective		3	
Architecture Elective		3 Architecture Elective		3	
		Architecture Elective		3	
12		15		5	

Total Credit Hours: 32

Doctor of Philosophy in Architecture

52 credit hours beyond the master's degree

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, which is offered in two tracks, Technologies of the Built Environment (TBE) and History, Theory, and Criticism (HTC), demands a deep understanding of the related theories in contemporary intellectual terrain, a command of advanced research methodologies, and a commitment to critical inquiry that extends the frontiers of knowledge.

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 also have the opportunity to participate in the experiments of design studios and later help guide these efforts in mentoring roles, helping to shape the debate within the college through their involvement in the college's "advanced studio."

Admission Requirements

An applicant to the doctoral program generally must hold a professional Master of Architecture degree (M.Arch.), or Master of Science in Architecture (M.S.Arch.) from a NAAB-accredited U.S. university or Master of Landscape Architecture (M.L.A.) from a LAAB-accredited U.S. university or the equivalent. Students with graduate degrees in allied fields, such as engineering and art history, are also eligible. Students holding a Bachelor of Architecture (B.Arch.) can apply through the Master of Science program at the College of Architecture.

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 their 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 within 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 qualifying examination in both written and oral formats. The student is also required to take and pass a comprehensive examination, often at the end of the second year, before they 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 the dissertation. Current areas of study include urban energy modeling, 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.

Code	Title	Credit Hours
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, MMAE 597, or PHIL 597.

² CAE 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, which is offered in two tracks, Technologies of the Built Environment (TBE) and History, Theory, and Criticism (HTC), demands a deep understanding of the related theories in contemporary intellectual terrain, a command of advanced research methodologies, and a commitment to critical inquiry that extends the frontiers of knowledge.

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 also have the opportunity to participate in the experiments of design studios and later help guide these efforts in mentoring roles, helping to shape the debate within the college through their involvement in the college's "advanced studio."

Admission Requirements

An applicant to the doctoral program generally must hold a professional Master of Architecture degree (M.Arch.), or Master of Science in Architecture (M.S.Arch.) from a NAAB-accredited U.S. university or Master of Landscape Architecture (M.L.A.) from an LAAB-accredited U.S. university or the equivalent. Students with graduate degrees in allied fields, such as engineering and art history, are also eligible. Students holding a Bachelor of Architecture (B.Arch.) can apply through the Master of Science program at the College of Architecture.

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 their 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 within 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 qualifying examination in both written and oral formats. The student is also required to take and pass a comprehensive examination, often at the end of the second year, before they 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 the dissertation. Current areas of study include urban energy modeling, 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.

Code	Title	Credit Hours
Required Courses		(18)
ARCH 500	Global Modernism	3
ARCH 501	Contemporary Architecture	3
ARCH 502	Adv Topics in Hist&Theory I	3
ARCH 503	Adv Topics in Hist&Theory II	3
ARCH 601	Research Methodologies	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, 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, which is offered in two tracks, Technologies of the Built Environment (TBE) and History, Theory, and Criticism (HTC), demands a deep understanding of the related theories in contemporary intellectual terrain, a command of advanced research methodologies, and a commitment to critical inquiry that extends the frontiers of knowledge.

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 also have the opportunity to

participate in the experiments of design studios and later help guide these efforts in mentoring roles, helping to shape the debate within the college through their involvement in the college's "advanced studio."

Admission Requirements

An applicant to the doctoral program generally must hold a professional Master of Architecture degree (M.Arch.), or Master of Science in Architecture (M.S.Arch.) from a NAAB-accredited U.S. university or Master of Landscape Architecture (M.L.A.) from an LAAB-accredited U.S. university or the equivalent. Students with graduate degrees in allied fields, such as engineering and art history, are also eligible. Students holding a Bachelor of Architecture (B.Arch.) can apply through the Master of Science program at the College of Architecture.

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 their 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 within 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 qualifying examination in both written and oral formats. The student is also required to take and pass a comprehensive examination, often at the end of the second year, before they 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 the dissertation. Current areas of study include urban energy modeling, 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 six credit hours of core courses. Another six 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).

Code	Title	Credit Hours
Required Courses		(12)
CAE 513	Building Science	3
ARCH 601	Research Methodologies	3
Select a minimum of two courses from the following:		6
CAE 502	Acoustics and Lighting	3
CAE 524	Building Enclosure Design	3
CAE 553	Measurement & Instrumentation	3
ENVE 576	Indoor Air Pollution	3
ARCH 485 or ARCH 486	Structures I Structures II	3
ARCH 487	Eco Structures	3
ARCH 488	Long-Span&Special Structures	3
ARCH 508	Design Communications III	3
ARCH 509	Topics in Advanced Technology	3
ARCH 551 or ARCH 552	Desn Energy-Efficient Bldg I Design of Energy-Eff Bldg II	3

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 Computing

Lance Fortnow

Dean

IIT Tower, Suite 1400

10 W. 35th Street

Chicago, IL 60616

312.567.5922

iit.edu/computing

The College of Computing, founded in 2020, is the newest college at Illinois Tech dedicated to ensuring students across campus have the computing and data science ideas and skills needed to succeed in today's technological society. The college offers dozens of degrees and certificates in computing from the foundational to the applied as well as mathematical and manufacturing processes through our four departments/programs: Applied Mathematics, Computer Science, Industrial Technology and Management and Information Technology and Management."

Applied Mathematics (p. 274)

- Master of Applied Mathematics (p. 284)
- Master of Science in Applied Mathematics (p. 289)
- Doctor of Philosophy in Applied Mathematics (p. 297)

JOINT DEGREE PROGRAMS

- Master of Data Science (with Computer Science) (p. 285)
- Master of Mathematical Finance (with Business) (p. 287)
- Master of Science in Computational Decision Sciences and Operations Research (with Computer Science) (p. 295)

Computer Science (p. 299)

- Master of Artificial Intelligence (p. 312)
- Master of Computer Science (p. 313)
- Master of Computer Science with specialization in: (p. 314)

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 Cybersecurity (p. 318)
- Master of Science in Computer Science (p. 323)
- Doctor of Philosophy in Computer Science (p. 325)

JOINT DEGREE PROGRAMS

- Master of Data Science (with Applied Mathematics) (p. 319)
- Master of Science in Computational Decision Sciences and Operations Research (with Applied Mathematics) (p. 321)

CERTIFICATES

- Computational Intelligence (p. 328)
- Cyber-Physical Systems (p. 328)
- Data Analytics (p. 328)
- Database Systems (p. 329)
- Distributed and Cloud Computing (p. 329)
- Information Security and Assurance (p. 330)

- Networking and Communications (p. 330)
- Software Engineering (p. 331)

Industrial Technology and Management (p. 332)

DEGREE PROGRAM

- Master of Industrial Technology and Operations (p. 337)

Information Technology and Management (p. 340)

DEGREE PROGRAMS

- Master of Cyber Forensics and Security (p. 353)
- Master of Information Technology and Management (p. 354)
- Master of Science in Applied Cybersecurity and Digital Forensics (p. 361)
- Master of Science in Information Technology and Management (p. 363)

CERTIFICATES

- Advanced Software Development (p. 366)
- Cyber Security Management (p. 366)
- Cyber Security Technologies (p. 367)
- Data Center Operations and Management (p. 367)
- Digital Voice and Data Communication Technologies (p. 368)
- Information Technology Innovation, Leadership, and Entrepreneurship (p. 368)
- System Administration (p. 369)
- Systems Analysis (p. 369)
- Web Design and Application Development (p. 370)

Applied Mathematics

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Chair

Chun Liu

Director, Graduate Studies

Igor Cialenco

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), analyzing the stochastic nature of financial markets (requiring probability/statistics, analysis, and optimization), understanding how liquids flow around solids, and how ions move in biological environments (requiring computational methods and analysis).

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 five areas of modern applied mathematics: applied analysis, computational mathematics, discrete applied mathematics, statistics, and stochastics. These areas are briefly described in the following subsections, which also include the faculty with primary and secondary research interests in that area.

Applied Analysis

The applied analysis group studies mathematical problems arising from physical, chemical, geophysical, biophysical, and materials sciences. These problems are often described by time-dependent partial, ordinary, or integral differential equations, together with sophisticated boundary conditions, interface conditions, and external forcing. Nonlinear dynamical systems offer a geometrical and topological framework for detecting, understanding, and quantifying complex phenomena of these time-dependent differential equations. Partial differential equation theory allows us to correctly formulate well-posed problems and to examine behaviors of solutions, and thus also allows us to set the stage for efficient numerical simulations. Nonlocal equations arise from macroscopic modeling of stochastic dynamical systems with Lévy noise and from modeling long range interactions, and consequently give an understanding of anomalous diffusions.

Faculty with primary interests: Duan, Liu, Lubin, Ong, Tier

Faculty with secondary interests: Bielecki, Cassel, Cialenco, Hickernell, S. Li, X. Li, Nair, Schieber, Weening

Computational Mathematics

Computer simulation is recognized as the third pillar of science, complementing theory and experiment. The computational mathematics research group designs and analyzes numerical algorithms and answers fundamental questions about the underlying physics. We construct and analyze algorithms for approximating functions and integration in high dimensions, and solving systems of polynomial equations. The emphasis is on meshfree methods, maximizing algorithm efficiency, avoiding catastrophic round-off error, overcoming the curse of dimensionality, and advancing adaptive computations to meet error tolerances. We develop accurate mathematical models and efficient numerical methods to investigate dynamics of interfaces. Our goal is to understand the underlying mechanisms that govern the process of pattern formation, i.e., growth and form. Examples include multi-phase flows in complex fluids, and vesicle deformation in bio-related applications such as drug delivery. We establish analytical and computational techniques for extracting effective dynamics from multiscale phenomena that are abundant in geophysical and biophysical systems.

Faculty with primary interests: Hickernell, S. Li, X. Li, Liu

Faculty with secondary interests: Cassel, Duan, Ong, Petrovic, Schieber

Discrete Applied Mathematics

The discrete mathematics group studies theoretical, algorithmic, and computational problems in the fields of graph theory, discrete optimization, combinatorics, and algebraic geometry, with applications in biology, computer science, physics, management sciences, and engineering. Network science, with fundamental concepts from graph theory and computational techniques from discrete optimization, is widely applied to problems arising in transportation/communication, distribution, and security of resources and information. Combinatorial search incorporates graph theory, set systems, and algorithms to tackle information-theoretic questions in topics such as message transmission, data compression, and identification of defective samples in a population. Computational algebra joins tools from algebraic geometry with randomized algorithms from discrete geometry to develop methods to solve systems of polynomial equations arising in statistical inference and mathematical modeling.

Faculty with primary interests: Ellis, Kaul, Pelsmajer, Petrovic, Reingold, Stasi, Weening

Statistics

The statistics research group works on applied problems in several areas of statistics from the theoretical, methodological, and computational points of view. Design and analysis of experiments with complex structures are used to help scientists gain higher-quality information from their lab work. Monte Carlo methods inform decisions depending on an unknown future by generating and analyzing a myriad of plausible scenarios. Algebraic statistics integrates algebra, geometry, and combinatorics into statistical modeling to provide better-fitting models for non-traditional data. Statistical network modeling and uncertainty quantification allow us to detect when certain data structures are more commonly observed than by chance. Bayesian statistics uses prior beliefs to inform statistical inference. We closely collaborate with scientists and engineers from many different disciplines such as mechanical, manufacturing, civil, and transportation engineering; social sciences; biology; neuroscience; business; and management.

Faculty with primary interests: Cialenco, Hickernell, Kang, Petrovic, Stasi

Faculty with secondary interests: Adler, Bielecki, Ellis, Gong

Stochastics

The research outcome of the stochastics group provides modeling tools for analysis, control, and numerical study of various stochastic systems that evolve in time and space, and are subject to randomness. Our study of structured dependence between stochastic processes helps to construct models of multivariate random dynamical systems with prescribed global structural features and prescribed marginal structural features. Random sequence comparison helps scientists to identify regions of similarity in the sequences of DNA, RNA, and proteins, or between strings in a natural language. Stochastic partial differential equations and stochastic dynamical systems serve as modeling tools for complex phenomena such as turbulent flows, climate change, and behavior of financial markets. Our research in the area of mathematical finance provides quantitative models of financial securities that allow pricing, hedging, and mitigating the risk of complex financial products.

Faculty with primary interests: Adler, Bielecki, Cialenco, Duan, Gong, Hickernell, Tier

Faculty with secondary interests: X. Li

Admission Requirements

Minimum Cumulative Undergraduate GPA

- Master's/Master of Science: 3.0/4.0
- Ph.D.: 3.5/4.0

Minimum GRE Scores

- Master's/Master of Science: 304 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 304 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

The applicants are also required to submit:

- at least two letters of recommendation
- a professional statement written in essay format (up to two pages long) that includes discussion of the reasons for pursuing graduate study, the applicant's academic background, relevant professional experience or related accomplishments to date, and applicant's career goals
- a curriculum vitae

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.

For admission requirements of the individual degree, see the corresponding program's graduate bulletin page.

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.

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. 284)
- Master of Science in Applied Mathematics (p. 289)
- Doctor of Philosophy in Applied Mathematics (p. 297)

Joint Degree Programs

- Master of Data Science (with Computer Science) (p. 285)
- Master of Mathematical Finance (with Business) (p. 287)
- Master of Science in Computational Decision Sciences and Operations Research (with Computer Science) (p. 295)

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or MATH 489 with min. grade of C

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.

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

MATH 519

Complex Analysis

Analytic functions, contour integration, singularities, series, conformal mapping, analytic continuation, multivalued functions.

Prerequisite(s): MATH 402 with min. grade of C

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): MATH 522 and CHEM 511

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 527

Machine Learning in Finance: From Theory to Practice

The purpose of this course is to introduce students to the theory and application of supervised and reinforcement learning to big data problems in finance. This course emphasizes the various mathematical frameworks for applying machine learning in quantitative finance, such as quantitative risk modeling with kernel learning and optimal investment with reinforcement learning. Neural networks are used to implement many of these mathematical frameworks in finance using real market data.

Prerequisite(s): MATH 475

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 532 with min. grade of C or MATH 332 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 475 with min. grade of C and MATH 400 with min. grade of C

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 with min. grade of C or MATH 333 with min. grade of C) and MATH 475 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or MATH 543 with min. grade of C or MATH 544 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MATH 546**Introduction to Time Series**

This course introduces the basic time series analysis and forecasting methods. Topics include stationary processes, ARMA models, spectral analysis, model and forecasting using ARMA models, nonstationary and seasonal time series models, multivariate time series, state-space models, and forecasting techniques.

Prerequisite(s): MATH 475 with min. grade of C or ECE 511 with min. grade of C

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 with min. grade of C or MATH 475 with min. grade of C

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 with min. grade of C

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, Turán-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 with min. grade of C

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 with min. grade of C or MATH 553 with min. grade of C

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 with min. grade of C and MATH 400 with min. grade of C

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 with min. grade of C

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 561**Algebraic and Geometric Methods in Statistics**

Algebraic structures are present in a broad variety of statistical contexts, involving both parametric and non-parametric statistical models for continuous and discrete random variables. A broad range of algebraic tools is used to better understand model structure, improve statistical inference, and explore new classes of models. The course offers an overview of fundamental theoretical constructions relevant to some of the more popular recent applications in the field: exact conditional test for discrete data, likelihood geometry, parameter identifiability and model selection, network models with applications to social sciences and neuroscience, and phylogenetics and tree-based evolutionary models in biology.

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.

Prerequisite(s): MATH 474 with min. grade of C or MATH 475 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MATH 564**Applied Statistics**

This course introduces the basic statistical regression model and design of experiments concepts. Topics include simple linear regression, multiple linear regression, least square estimates of parameters; hypothesis testing and confidence intervals in linear regression, testing of models, data analysis and appropriateness of models, generalized linear models, design and analysis of single-factor experiments.

Prerequisite(s): MATH 474 with min. grade of C or MATH 476 with min. grade of C or MATH 563 with min. grade of C

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 with min. grade of C

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 with min. grade of C and MATH 564 with min. grade of C and MATH 563 with min. grade of C

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 with min. grade of C or MATH 476 with min. grade of C

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 with min. grade of C

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 474 with min. grade of C or MATH 475 with min. grade of C) and MATH 350 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

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.

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): SCI 522 with min. grade of C and (CSP 571 with min. grade of C or MATH 571 with min. grade of C)

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 350 with min. grade of C or MATH 489 with min. grade of C

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 485 with min. grade of C or MATH 548 with min. grade of C) and (MATH 481 with min. grade of C or MATH 542 with min. grade of C)

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

MATH 584**Mathematical Methods for Algorithmic Trading**

This course is concerned with the design and implementation of trading strategies. In particular, it covers the mean-variance portfolio selection problem, utility maximization, pairs trading, market making, and optimal liquidation. The analysis includes such important features as: the construction and usage of predictive signals, finding a tradeoff between risk and return, accounting for transaction costs and market impact. The available mathematical tools and models are presented in each case, and they include: methods for solving constrained optimization problems, stochastic control and dynamic programming principle, time-series analysis. An important part of the course is the implementation of trading algorithms via Python, using real market data. (3-0-3)

Prerequisite(s): (MATH 481 or MATH 542 with min. grade of C or MATH 543 with min. grade of C) and (MATH 485 or MATH 548 with min. grade of C or MATH 582 with min. grade of C)

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 hands-on familiarity with and understanding of the modern approaches used in practice to model interest rate markets.

Prerequisite(s): (MATH 481* with min. grade of C or MATH 542 with min. grade of C) and (MATH 485 with min. grade of C or MATH 548 with min. grade of C), 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 with min. grade of C

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

MATH 588**Advanced Quantitative Risk Management**

This is an advanced course on quantitative risk management. The major concepts and ideas from the modern risk management will be explained and illustrated. The course builds upon general theory of risk measures and performance measures and addresses the current regulatory requirements for market participants.

Prerequisite(s): MATH 548 with min. grade of C

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 with min. grade of C and MATH 489 with min. grade of C

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:** 6 **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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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

SCI 595**Ethics for the Health Professions**

Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.

Lecture: 1 Lab: 0 Credits: 1

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, statistics, 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.

Admission Requirements

Students are required to have a bachelor's degree in mathematics, science, engineering, business, or an equivalent degree, with a minimum GPA of 3.0/4.0. Applicants are evaluated on an individual basis, but students are expected to have taken the following courses (or equivalent courses): Differential Equations, Matrix or Linear Algebra, Probability or Statistics, and a Computer Programming language (e.g. Matlab, C, or R). Graduate Record Examination (GRE) scores must be submitted with the following minimum scores: 304 (quantitative + verbal), and 2.5 (analytical writing). Any applicant whose undergraduate degree was earned at an institution where the primary language of instruction is not English must submit Test of English as a Foreign Language (TOEFL), Pearson Test of English (PTE), or International English Language Testing System (IELTS) scores, which must satisfy Illinois Institute of Technology's English language proficiency test requirements (see the Graduate Admission section (p. 11) for more information). A professional statement of objectives must be submitted and at least one letter of recommendation is required.

Curriculum

Code	Title	Credit Hours
Applied Mathematics and Computational Science Core		(9)
MATH 475	Probability	3
MATH 522 or MATH 564	Mathematical Modeling Applied Statistics	3
MATH 577	Computational Mathematics I	3
Business and Professional Core		(3)
SCI 511 or SCI 522	Project Management Public Engagement Scientists	3
Capstone Professional Experience		(9)
MATH 523 or MATH 592	Case Studies & Project Design Internship in Applied Math	6
MATH 594	Professional Master's Project	3
Elective Courses		(9)
Select a minimum of three courses from the following:		9
Advanced Computation		
MATH 461 or MATH 489	Fourier Sers&Boudary-Val Probs Partial Differential Equations	3
MATH 565	Monte Carlo Methods in Fin	3
MATH 578	Computational Mathematics II	3
MATH 581	Finite Element Method	3
MATH 589	Num Meth for Partial Diff Equa	3
CS 595	Topics in Computer Science	3-12
MSF 526	Computational Finance	3
Stochastic Modeling and Analysis		
MATH 481	Intro to Stochastic Processes	3
MATH 485	Intro 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 Fin	3

MATH 567	Adv Design of Experiments	3
MATH 574	Bayesian Computational Stats	3
Discrete Mathematics and Optimization		
MATH 535	Optimization I	3
MATH 553	Discrete Applied Mathematics I	3
MATH 554	Discrete Applied Math 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 21 credit hours of required, core courses. Nine credit hours of electives, selected in consultation with, and approval of, the program director are required. The program may include a maximum of nine credit hours at the 400-level.

Capstone Professional Experience

The capstone consists of a six credit hour course in case studies and project management or an internship in applied mathematics.

Master's Project

The project, which is three 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 six credit hour practicum project. The program is designed primarily for those with previous degrees or experience in computer science, statistics, mathematics, the natural or social sciences, or business, and 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 analytical writing score of at least 3.0 are required. The GRE requirement may 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.

Prerequisites include knowledge of a high level programming language at the level of CS 201 (object-oriented programming is required), a data structures and algorithms course at the level of CS 331, multivariate calculus at the level of MATH 251, 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 bulletin. Proficiency and placement exams are also available.

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, nine credit hours of elective courses, and six credit hours of CSP 572/MATH 572 Data Science Practicum. At least nine credit hours must be taken of 400- or 500-level CS or CSP courses and nine credit hours of 400- or 500-level MATH courses, not including the CSP 572/MATH 572 Data Science Practicum.

Up to six credit hours of 400-level undergraduate coursework may be used toward degree requirements.

Code	Title	Credit Hours
Data Science Core Courses		(18)
MATH 563	Mathematical Statistics	3
or MATH 564	Applied Statistics	

CS 584	Machine Learning	3
or MATH 569	Statistical Learning	
SCI 511	Project Management	3
or CS 587	Software Project Management	
SCI 522	Public Engagement Scientists	3
CSP 571	Data Preparation and Analysis	3
Select a minimum of one course from the following:		3
CS 525	Advanced Database Organization	3
CS 554	Data-Intensive Computing	3
CSP 554	Big Data Technologies	3
Data Science Capstone		(6)
CSP/MATH 572	Data Science Practicum (Summer only)	6
Data Science Electives		(9)
Select nine credit hours of Data Science Electives		9
Total Credit Hours		33

Data Science Electives

Code	Title	Credit Hours
Computational Fundamentals		(36)
CS 425	Database Organization	3
CS 430	Introduction to Algorithms	3
CS 450	Operating Systems	3
CS 520	Data Integration Warehousing	3
CS 525	Advanced Database Organization	3
CS 528	Data Privacy and Security	3
CS 535	Dsgn and Anlys of Algorithms	3
CS 546	Parallel and Distributed Proc	3
CS 553	Cloud Computing	3
CS 554	Data-Intensive Computing	3
CS 589	Software Testing and Anlys	3
CSP 554	Big Data Technologies	3
Computer Science Applications		(39)
CS 422	Data Mining	3
CS 512	Computer Vision	3
CS 513	Geospatial Vision/Visualizatio	3
CS 522	Advanced Data Mining	3
CS 529	Information Retrieval	3
CS 556	Cyber-Physical Sys: Lang & Sys	3
CS 557	Cyber-Physical Sys Sec/Dsgn	3
CS 577	Deep Learning	3
CS 578	Interact/Trans Mach Learning	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		(48)
MATH 454	Graph Theory and Applications	3
MATH 481	Intro to Stochastic Processes	3
MATH 483	Design and Analysis of Exprmnt	3
MATH 486	Mathematical Modeling I	3
MATH 487	Mathematical Modeling II	3
MATH 522	Mathematical Modeling	3

MATH 532	Linear Algebra	3
MATH 535	Optimization I	3
MATH 540	Probability	3
MATH 542	Stochastic Processes	3
MATH 546	Introduction to Time Series	3
MATH 565	Monte Carlo Methods in Fin	3
MATH 566	Multivariate Analysis	3
MATH 567	Adv Design of Experiments	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Stats	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 Data Science Curriculum

					Year 1
Semester 1	Credit Hours	Semester 2	Credit Hours	Semester 3	Credit Hours
CS 525, 554, or CSP 554		3 CS 584 or MATH 569		3 CSP 572	6
MATH 563 or 564		3 CSP 571		3	
SCI 511 or CS 587		3 Data Science Elective		3	
	9		9		6
					Year 2
Semester 1	Credit Hours				
SCI 522	3				
Data Science Elective	3				
Data Science Elective	3				
	9				

Total Credit Hours: 33

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.

Admission Requirements

Admission to the Master of Mathematical Finance program requires a bachelor's degree in a quantitative discipline such as mathematics, quantitative finance, engineering, or statistics with a minimum cumulative GPA of 3.0/4.0. Applicants are required to have a background in undergraduate-level probability theory, multivariate calculus, and linear algebra. Background in ordinary differential equations will enhance the chance of admission to the program. If required, TOEFL scores should be a minimum of 90/250 (internet-based/computer-based test score) or the IELTS score should be a minimum of 6.5. A professional statement of goals/objectives (two pages) and a curriculum vitae must be submitted. Two letters of recommendation are required (at least one must be from academia). 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 some 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.

Curriculum

Code	Title	Credit Hours
Core Courses		(24)
MSF 505 or MSF 524	Futures/Option/OTC Derivatives Models for Derivatives	3
MSF 526	Computational Finance	3
MATH 542	Stochastic Processes	3
MATH 548	Mathematical Finance I	3
MATH 565	Monte Carlo Methods in Fin	3
MATH 582	Mathematical Finance II	3
MATH 586	Ther&Prac Fixed Income Modelng	3
MATH 588	Advanced Quant Risk Mgmt	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 527	Machine Learning in Finance:	3
MATH 540	Probability	3
MATH 543	Stochastic Analysis	3
MATH 544	Stochastic Dynamics	3
MATH 545	Stochastic Partial Diff Equatn	3
MATH 546	Introduction to Time Series	3
MATH 566	Multivariate Analysis	3
MATH 567	Adv 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 Prob	3
MATH 587	Thry/Prac Modlng&Crdt Deritvs	3
MATH 589	Num Meth for Partial Diff Equa	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 Struc Mod & Int Rate Der	3
MSF 545	Struct Fixed Income Portfolios	3
MSF 546	Quant 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 575	C++ with Financial Markets	3
MSF 576	OOP & Algorithmic Trading Sys	3
MSF 577	High Frequency Finance	3
MSF 584	Equity & Equity Deriv Trading	3
MSF 585	FOREX & Fixed Income Strat	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

The Master of Science in Applied Mathematics program at Illinois Tech is a modern graduate program tailored to serve students based on their academic background and future career goals. For students who wish to pursue a doctoral degree in the mathematical sciences, it provides a strong academic foundation that prepares the student for the challenge of Ph.D. coursework and research. For students who wish to pursue careers in industry, Illinois Tech trains students in state-of-the-art advanced mathematical techniques and models that are appealing to future employers. These options are possible due to the remarkably flexible structure of the program that allows students to craft their own coursework to meet their career goals by choosing one of the three options of study:

1. Coursework only option
2. Completing an industry-based project
3. Writing an M.S. thesis

In addition, students can choose a specialization from a wide range of contemporary areas of applied mathematics:

- Computational Statistics for Data Science
- Discrete Computation and Optimization
- Industrial Mathematics
- Quantitative Risk Management
- Stochastic Computation

Students satisfying the requirements of a specialization will have the specialization recognized on official transcripts.

Admission Requirements

The 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. 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 2.5 are required. TOEFL scores (if required) should be a minimum of 80/550 (internet-based/paper-based test scores). A professional statement of goals/objectives (two pages) and a curriculum vitae must be submitted. Two letters of recommendation are required. Students must remove deficiencies in essential undergraduate courses that are prerequisites for the degree program, in addition to fulfilling all other degree requirements. Typically, admitted students score at least 156 on the quantitative portion of the GRE; however, meeting the minimum or typical GPA and test score requirements does not guarantee admission.

The Director of Graduate Studies serves as temporary academic adviser for newly admitted graduate students in the master of science 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.

Curriculum

Students may 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.

General Program Requirements

1. All students will follow the requirements for core courses as given below.
2. All students will choose one of the following three options:
 - a. *Coursework Only Option.* Students must pass the comprehensive exam, consisting of two exams corresponding to the courses MATH 500, MATH 540, MATH 553, MATH 563, and MATH 577, which must be passed at a master's level or above.
 - b. *Master's Project Option.* Perform an industrial project for three to five credit hours taken as MATH 594. A project may focus on the applications of existing methodologies or mathematical modeling of a real-life phenomenon, possibly from outside mathematics, including industry sponsored group projects. This option also requires MATH 522 and the completion of a formal specialization.
 - c. *M.S. Thesis Option.* M.S. Thesis for five to eight credit hours taken as MATH 591. A thesis should go into substantial depth on a topic or problem from a methodological or mathematical perspective and make a contribution towards the advancement of mathematical understanding of the problem under study.
3. All students will take the colloquium course MATH 593 (zero credit hours) at least one semester.
4. All students will take their remaining credit hours from the elective courses listed below or other courses with the approval of the academic adviser.
5. Students will maintain a GPA of at least 3.0 in their coursework.
6. Students in the coursework only option or thesis option may complete one of the listed specializations, but are not required to do so.

Master of Science in Applied Mathematics (Coursework Only Option)

Requirement		Credits
Minimum Degree Credits		32
Maximum 400-Level Credit		9
Minimum MATH Credit		25
Code	Title	Credit Hours
Core Courses		(9) ¹
MATH 577	Computational Mathematics I	3
Select a minimum of six credit hours from the following:		6
MATH 500 or MATH 400	Applied Analysis I Real Analysis	3
MATH 540 or MATH 475	Probability ² Probability	3
MATH 553 or MATH 454	Discrete Applied Mathematics I Graph Theory and Applications	3
MATH 563 or MATH 476	Mathematical Statistics ³ Statistics	3
Additional Requirements		(0)
MATH 593	Seminar in Applied Mathematics	0
Elective Courses		(23)
Select 23 credit hours ⁴		23
Total Credit Hours		32

¹ Students in the coursework only option must pass the comprehensive exam, consisting of two exams corresponding to the courses MATH 500, MATH 540, MATH 553, MATH 563, and MATH 577, which must be passed at a master's level or above.

- ² MATH 540 or MATH 475 is required for students pursuing specializations in Stochastic Computation, Computational Statistics for Data Science, or Quantitative Risk Management.
- ³ MATH 563 is required for students pursuing a specialization in Computational Statistics for Data Science.
- ⁴ The remaining courses in each student's program are selected in consultation with, and approval of, the Director of Graduate Studies. Students pursuing a specialization should choose approved courses specific to their specialization. See the Specializations tab on this page for more details.

Master of Science in Applied Mathematics (Master's Project Option)

Requirement	Credits
Minimum Degree Credits	32
Maximum 400-Level Credit	9
Minimum MATH Credit	25

Code	Title	Credit Hours
Core Courses		(9)
MATH 522	Mathematical Modeling	3
MATH 577	Computational Mathematics I	3
Select a minimum of three credit hours from the following:		3
MATH 500 or MATH 400	Applied Analysis I Real Analysis	3
MATH 540 or MATH 475	Probability ¹ Probability	3
MATH 553 or MATH 454	Discrete Applied Mathematics I Graph Theory and Applications	3
MATH 563 or MATH 476	Mathematical Statistics ² Statistics	3
Additional Requirements		(0)
MATH 593	Seminar in Applied Mathematics	0
Specialization Courses		(9-15)
Select 9-15 credit hours from an approved specialization ³		9-15
Master's Project		(3-5)
MATH 594	Professional Master's Project	3-5
Elective Courses		(3-11)
Select 3-11 credit hours ⁴		3-11

- ¹ MATH 540 or MATH 475 is required for students pursuing specializations in Industrial Mathematics, Stochastic Computation, Computational Statistics for Data Science, or Quantitative Risk Management.
- ² MATH 563 is required for students pursuing a specialization in Computational Statistics for Data Science.
- ³ Students should choose approved courses specific to their specialization. See the Specializations tab on this page for more details.
- ⁴ The remaining courses in each student's program are selected in consultation with, and approval of, the Director of Graduate Studies.

Master of Science in Applied Mathematics (Thesis Option)

Requirement	Credits
Minimum Degree Credits	32
Maximum 400-Level Credit	9
Minimum MATH Credit	25

Code	Title	Credit Hours
Core Courses		(9)
MATH 577	Computational Mathematics I	3
Select six credit hours from the following:		6
MATH 500 or MATH 400	Applied Analysis I Real Analysis	3
MATH 540	Probability ¹	3

or MATH 475	Probability	
MATH 553	Discrete Applied Mathematics I	3
or MATH 454	Graph Theory and Applications	
MATH 563	Mathematical Statistics ²	3
or MATH 476	Statistics	
Additional Requirements		(0)
MATH 593	Seminar in Applied Mathematics	0
Elective Courses		(15-18)
Select 15-18 credit hours ³		15-18
Thesis Research		(5-8)
MATH 591	Research and Thesis M.S.	5-8

¹ MATH 540 or MATH 475 is required for students pursuing specializations in Stochastic Computation, Computational Statistics for Data Science, or Quantitative Risk Management.

² MATH 563 is required for students pursuing a specialization in Computational Statistics for Data Science.

³ The remaining courses in each student's program are selected in consultation with, and approval of, the Director of Graduate Studies. Students pursuing a specialization should choose approved courses specific to their specialization. See the Specializations tab on this page for more details.

Comprehensive Examination

The comprehensive examination requirement is fulfilled by either (a) passing written tests in two of the five core areas of study at the master of science level; or (b) performing an industrial project (three to five credit hours of MATH 594), satisfying the requirements for one specialization, and taking MATH 522; or (c) a master's thesis (five to eight credit hours of MATH 591) under the supervision of a faculty member.

Specializations

Computational Statistics for Data Science

Code	Title	Credit Hours
Required Courses		(9)
MATH 540	Probability ¹	3
or MATH 475	Probability	
MATH 563	Mathematical Statistics ¹	3
MATH 564	Applied Statistics	3
Elective Courses		(0) ²
BIOL 550	Bioinformatics	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
ECE 566	Machine and Deep Learning	3
MATH 483	Design and Analysis of Experiments	3
MATH 535	Optimization I	3
MATH 542	Stochastic Processes	3
or MATH 481	Intro to Stochastic Processes	
MATH 546	Introduction to Time Series	3
or MATH 446	Introduction to Time Series	
MATH 561	Algebraic & Geometric Methods	3
MATH 565	Monte Carlo Methods in Finance	3
MATH 567	Advanced Design of Experiments	3
or MATH 483	Design and Analysis of Experiments	
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Statistics	3
MATH 578	Computational Mathematics II	3

MATH 590	Meshfree Methods	3
PHYS 440	Computational Physics	3

¹ MATH 540, MATH 475, and MATH 563 may be used to satisfy both the core degree requirements and specialization requirements.

² Students may also select core course options that were not used to satisfy the core course requirement.

Discrete Computation and Optimization

Code	Title	Credit Hours
Required Courses		(9)
Select nine credit hours from the following:		9
MATH 530	Applied/Computational Algebra	3
MATH 535	Optimization I	3
MATH 553	Discrete Applied Mathematics I	3
MATH 554	Discrete Applied Math II	3
MATH 569	Statistical Learning	3
Elective Courses		(0)²
CS 535	Dsgn and Anlys of Algorithms	3
CS 539	Game Theory: Algorithms & Apps	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 584	Machine Learning	3
ECE 519	Coding Reliable Communications	3
ECE 565	Compt Vision Image Processing	3
MATH 430	Applied Algebra	3
MATH 454	Graph Theory and Applications ¹	3
MATH 542	Stochastic Processes	3
or MATH 481	Intro to Stochastic Processes	
MATH 546	Introduction to Time Series	3
or MATH 446	Introduction to Time Series	
MATH 561	Algebraic & Geometric Methods	3
MATH 563	Mathematical Statistics	3
or MATH 564	Applied Statistics	
MATH 565	Monte Carlo Methods in Fin	3
MATH 567	Adv Design of Experiments	3
or MATH 483	Design and Analysis of Exprmnt	
MATH 574	Bayesian Computational Stats	3

¹ MATH 454 may not be taken if the student has already completed MATH 553.

² Students may also select core course options that were not used to satisfy the core course requirement.

Industrial Mathematics

Note: The master's project track is required to pursue this specialization.

Code	Title	Credit Hours
Required Courses		(15)
MATH 540	Probability ¹	3
or MATH 475	Probability	
MATH 522	Mathematical Modeling ¹	3
SCI 511	Project Management	3
or SCI 522	Public Engagement Scientists	
MATH 523	Case Studies & Project Design	6
or MATH 592	Internship in Applied Math	
Elective Courses		(0)²
CS 535	Dsgn and Anlys of Algorithms	3

CS 539	Game Theory: Algorithms & Apps	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 584	Machine Learning	3
MATH 430	Applied Algebra	3
MATH 454	Graph Theory and Applications ²	3
MATH 542	Stochastic Processes	3
or MATH 481	Intro to Stochastic Processes	
MATH 546	Introduction to Time Series	3
or MATH 446	Introduction to Time Series	
MATH 561	Algebraic & Geometric Methods	3
MATH 563	Mathematical Statistics	3
or MATH 564	Applied Statistics	
MATH 565	Monte Carlo Methods in Fin	3
MATH 567	Adv Design of Experiments	3
or MATH 483	Design and Analysis of Exprmnt	
MATH 574	Bayesian Computational Stats	3

¹ MATH 540, MATH 475, and MATH 522 may be used to satisfy both the core degree requirements and specialization requirements.

² Students may also select core course options that were not used to satisfy the core course requirement.

Quantitative Risk Management

Code	Title	Credit Hours
Required Courses		(12)
MATH 540	Probability ¹	3
or MATH 475	Probability	
MATH 542	Stochastic Processes	3
or MATH 543	Stochastic Analysis	
MATH 588	Advanced Quant Risk Mgmt	3
MATH 565	Monte Carlo Methods in Fin	3
or MATH 582	Mathematical Finance II	
or MATH 587	Thry/Prac Modlng&Crdt Deritvs	
Elective Courses		(0) ²
MATH 543	Stochastic Analysis	3
MATH 544	Stochastic Dynamics	3
or MATH 545	Stochastic Partial Diff Equatn	
MATH 546	Introduction to Time Series	3
or MATH 566	Multivariate Analysis	
MATH 563	Mathematical Statistics	3
or MATH 564	Applied Statistics	
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Stats	3
MATH 578	Computational Mathematics II	3
MATH 581	Finite Element Method	3
or MATH 589	Num Meth for Partial Diff Equa	
or MATH 590	Meshfree Methods	
MATH 586	Ther&Prac Fixed Income Modelng	3

¹ MATH 540 or MATH 475 may be used to satisfy both the core degree requirements and specialization requirements.

² Students may also select core course options that were not used to satisfy the core course requirement.

Stochastic Computation

Code	Title	Credit Hours
Required Courses		(12)
MATH 540	Probability ¹	3
or MATH 475	Probability	
Select nine credit hours from the following:		9
MATH 542	Stochastic Processes	3
or MATH 543	Stochastic Analysis	
MATH 544	Stochastic Dynamics	3
MATH 545	Stochastic Partial Diff Equatn	3
MATH 565	Monte Carlo Methods in Fin	3
MATH 574	Bayesian Computational Stats	3
Elective Courses		(0) ²
CS 595	Topics in Computer Science (Advanced Scientific Computing)	3
MATH 522	Mathematical Modeling	3
MATH 530	Applied/Computational Algebra	3
MATH 546	Introduction to Time Series	3
MATH 569	Statistical Learning	3
MATH 573	Reliable Mathematical Software	0
MATH 578	Computational Mathematics II	3
MATH 589	Num Meth for Partial Diff Equa	3

¹ MATH 540 or MATH 475 may be used to satisfy both the core degree requirements and specialization requirements.

² Students may also select core course options that were not used to satisfy the core course requirement.

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 five 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	Dsgn and Anlys of Algorithms	
MATH 481	Intro to Stochastic Processes	3
or MATH 564	Applied Statistics	

or MATH 565	Monte Carlo Methods in Fin	
CS 539	Game Theory: Algorithms & Apps	3
or CS 584	Machine Learning	
or MBA 505	Microeconomics 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	3
CS 522	Advanced Data Mining	3
CS 525	Advanced Database Organization	3
CS 529	Information Retrieval	3
CS 554	Data-Intensive Computing	3
CS 577	Deep Learning	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 585	Natural Language Processing	3
CS 595	Topics in Computer Science	3
CS 597	Reading and Special Problems	1-3
Applied Math Electives		(3)
Select a minimum of one course from the following:		3
MATH 483	Design and Analysis of Exprmnt	3
MATH 485	Intro to Mathematical Finance	3
MATH 522	Mathematical Modeling	3
MATH 546	Introduction to Time Series	3
MATH 548	Mathematical Finance I	3
MATH 553	Discrete Applied Mathematics I	3
MATH 554	Discrete Applied Math II	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Stats	3
MATH 597	Reading and Special Projects	1-3
Business and Application Electives		(3)
Select a minimum of one course from the following:		3
BUS 510	Strategy & Innovation	3
CAE 581	Algorithms in Transportation	3
MBA 504	Analytics for Decision Making	3
MBA 513	Operations & Tech Management	3
MBA 526	Supply Chain Management	3
MSC 511	Math for Mgmt Science I	3
MSC 514	Math for Mgmt Science II	3
Research		(0-5)
Select zero to five credit hours		0-5
CS 591	Reseach and Thesis M.S.	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 five 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 advanced coursework, independent study, and original, creative research to make a significant contribution to the field of applied mathematics and to prepare students for careers in academia and industrial research.

Admission Requirements

The 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. Applicants should have a bachelor's degree from an accredited university. A cumulative GPA of 3.5/4.0 is usually required. The applicants must also have demonstrated the potential for conducting original research in applied mathematics. A combined verbal and quantitative GRE examination score of at least 304, and an analytic writing score of at least 3.0 are required. TOEFL scores (if required) should be a minimum of 80/550 (internet-based/paper-based test scores). A professional statement of goals/objectives (two pages) and a curriculum vitae must be submitted. Three letters of recommendation are required. Students must remove deficiencies in essential undergraduate courses that are prerequisites for the degree program, in addition to fulfilling all other degree requirements. Typically, admitted students score at least 165 on the quantitative portion of the GRE; however, meeting the minimum or typical GPA and test score requirements does not guarantee admission.

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 research adviser. Students are responsible for following all departmental procedures, as well as the general requirements of the Graduate College.

Curriculum

Code	Title	Credit Hours
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 9-27 credit hours 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 pass three written qualifying exams at the Ph.D. level: 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 that the student takes 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 their 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.

Computer Science

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Associate Chairs

Cynthia Hood
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 several state-of-the-art computer facilities. These include a large-scale OpenStack system, a large-scale Sun ComputeFarm consisting of 108 processors, a 17-node Dell PowerEdge Linux-based cluster, an IBM Linux cluster consisting of 28 processors, and a Cray XD1 supercomputer containing six 2-way SMP nodes with 12 2.2GHz Opteron-248 processors and 12GB memory. The department was selected by Nvidia as one of its CUDA Teaching Centers where Nvidia provided a GPU-enabled computing cluster, committed to advancing the state of parallel processing in the computer science department. The department and the university have several other teaching and research clusters that are available to students.

Research Areas

Algorithms, artificial intelligence, bioinformatics, cloud computing, computational science, computer architecture, computer graphics, computer networking and telecommunications, computer vision, cyber-physical systems, cyber security, data mining, data structures, database systems, distributed and parallel systems, high-performance computing, I/O systems, information retrieval, machine learning, natural language processing, scientific computing, social computing, software engineering, and wireless networks.

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

Minimum Cumulative Undergraduate GPA

3.0/4.0, with a four-year degree or its equivalent¹

Minimum Cumulative Master of Science GPA

- Ph.D.: 3.5/4.0, for applicants with a master's degree in or related to computer science
- Master's degrees: 3.0/4.0, for applicants with a master's degree (not necessarily in computer science)

Minimum GRE Scores

- Master of Computer Science, Master of Cybersecurity, Master of Telecommunications and Software Engineering: 295 (quantitative + verbal), 2.5 (analytical writing)²
- Master of Science in Computer Science: 300 (quantitative + verbal), 3.0 (analytical writing)
- Master of Artificial Intelligence, Master of Data Science: 304 (quantitative + verbal), 3.0 (analytical writing)

- Master of Science in Computational Decision Science and Operations Research: 304 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 304 (quantitative + verbal), 3.5 (analytical writing) for applicants with a master's degree in or related to computer science; 310 (quantitative + verbal), 4.0 (analytical writing) for applicants with a bachelor's degree in computer science. In addition, the GRE quantitative score must be at least 70th percentile.

Minimum English Proficiency

- A degree from a school where the primary language was English
- Otherwise, a TOEFL score of 70, a PTE score of 47, or an IELTS score of 5.5

Also required are a personal statement and letters of recommendation (two for master's degrees, three for the Ph.D.). The entire admission application is considered in an admission decision; meeting minimum GPA and test score requirements does not guarantee admission.

Prerequisite Undergraduate Coursework

Master's program, certificate, and non-degree applicants with bachelor's degrees outside of computer science may be required to complete one or more of the following courses. Mastery of the material they cover is considered necessary for graduate-level study and is required for completion of a degree program or certificate. In addition, applicants who have not had at least one course in calculus will be required to take one. Grades of "B" or better are required in all these courses; credit hours from them cannot be applied toward a degree or certificate.

CS 201	Accelerated Introduction to Computer Science	4
CS 401	Introduction to Advanced Studies I	3
CS 402	Introduction to Advanced Studies II	3

¹ A three-year degree from certain European schools is acceptable. Otherwise, master's program applicants with a three-year bachelor's degree must also have completed a two-year master's degree in the same area, with a GPA of 3.0/4.0 or better. Applicants currently pursuing a graduate degree in a different field or at another university must be in good academic standing. A potential applicant with a GPA less than 3.0 but greater than 2.5 may be able to take courses as a special non-degree graduate student. See the department website (science.iit.edu/computer-science) for details.

² The GRE requirement can be waived, on a case-by-case basis, 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.

Degrees Offered

- Master of Artificial Intelligence (p. 312)
- Master of Computer Science (p. 313)
- Master of Computer Science with specialization in: (p. 314)

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 Cybersecurity (p. 318)
- Master of Science in Computer Science (p. 323)
- Doctor of Philosophy in Computer Science (p. 325)

Joint Degree Programs

- Master of Data Science (with Applied Mathematics) (p. 319)
- Master of Science in Computational Decision Sciences and Operations Research (with Applied Mathematics) (p. 321)

Certificate Programs

- Computational Intelligence (p. 328)
- Cyber-Physical Systems (p. 328)
- Data Analytics (p. 328)
- Database Systems (p. 329)
- Distributed and Cloud Computing (p. 329)
- Information Security and Assurance (p. 330)
- Networking and Communications (p. 330)
- Software Engineering (p. 331)

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 with min. grade of C

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 with min. grade of C

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 emphasizes practical 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 with min. grade of C

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 with min. grade of C or CS 487 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 528**Data Privacy and Security**

New technologies have increasingly enabled corporations and governments to collect, analyze and share huge amount of data related to individuals. Today, the challenge is enabling the legitimate use of the collected data without violating privacy and security. In this course, we are going to analyze the fundamental models of ensuring data privacy and security, and explore potential theoretical models, algorithms, and technologies that can enhance data privacy and security in different contexts, such as market basket, search engine, location-based services, social network, cloud computing, cryptocurrencies, and smart grid. We will also design and implement different techniques (e.g., cryptographic protocols, secure computation, and data sanitization) as well as examine their performance in terms of three critical properties (privacy/security, utility and efficiency).

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 532**Formal Languages**

This course provides an introduction to the theory of formal languages and machines. Topics to be covered include: strings, alphabets, and languages; grammars, the Chomsky Hierarchy of languages and corresponding machines (regular sets and finite automata, context free languages of various types, Turing machines and recursive functions, undecidable problems), and computational complexity, polynomial-time reductions, NP-completeness.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or CS 401 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or CS 530 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or ECE 545 with min. grade of C

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 with min. grade of C

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 450 with min. grade of C and CS 430 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 548**High-Speed 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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 549**Cryptography**

Cryptography provides foundations for ensuring the confidentiality, authenticity, integrity and privacy of the increasing sensitive information in digital world. It is a theoretical field that relies on a diverse and wide variety of mathematics. The topics in this course include encryption, message authentication codes, digital signatures, public key crypto-systems, key exchange, identification protocols, zero-knowledge proof systems, etc. The goal of this course is to help students develop a solid understanding of the fundamentals of security and become familiar with the theories of cryptography as well as the role of cryptography in the recent and emerging applications.

Prerequisite(s): CS 430 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C or CS 455 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 Security and Design**

In this course, we will examine the security and privacy issues in the vast implementations of Cyber-physical systems (CPS). According to the definition, CPS refers to a system that has both physical and software components, and they are all controlled or monitored by computer-based algorithms. CPS, or IoT systems touch many aspects of life, including transportation, health care, safety, environment, energy, and more. We will examine how existing security mechanisms can be applied to the CPS system, why such protections are not enough, and study the trend of security system design in the area. In addition, we will examine and discuss CPS/IoT technology and market specific topics, relevant case studies of system security vulnerabilities and attacks, and mitigation controls. We will have several case studies in current CPS/IoT systems and students will assess the health, safety, privacy, and economic impacts of IoT security events. Also, students will need to review research papers related to course topics and present a final project report at the end of the course.

Prerequisite(s): CS 450

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 with min. grade of C or CS 455 with min. grade of C or CS 458 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 559**Biometrics**

In a security conscious society, biometrics-based authentication and identification have become a central focus for many important applications as biometrics can provide accurate and reliable identification. Biometrics research and technology continue to mature rapidly, driven by pressing industrial and government needs and supported by industrial and government funding. This course offers an introduction to major biometric techniques, the underlying pattern recognition and computer vision basis for these biometrics, scientific testing and evaluation methodologies of biometrics systems, a deeper study of facial recognition, and an examination of the current privacy and social/ethical issues surrounding the technology. The course includes readings from the literature, short writing assignments, and practical experience with current biometric technology. Prerequisite working knowledge of Matlab or C/C++ is necessary.

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 562**Virtual Machines**

This is an advanced systems course which introduces the internals of modern virtualization software and hardware, from full system emulators, binary translators, and high-level language virtual machines to hypervisors, lightweight virtualization mechanisms such as containers, and hardware virtualization extensions. Students will learn the key abstractions and mechanisms that underly resource virtualization by building significant components of real-world systems.

Prerequisite(s): CS 450 with min. grade of C or CS 551 with min. grade of C

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 with min. grade of C or CS 561 with min. grade of C

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 561 with min. grade of C and CS 560 with min. grade of C

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 470 with min. grade of C and CS 450 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 572**Advanced Topics in Computer Architecture**

Current problems in computer architecture.

Prerequisite(s): CS 570 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 577**Deep Learning**

Deep neural networks form an important sub-field of machine learning that is responsible for much of the progress in cognitive computing in recent years in areas of computer vision, audio processing, and natural language processing. Deep networks can be trained with a single end-to-end model and bypass the need for traditional task-specific feature engineering. In this way deep learning simplifies learning tasks and allows using developed models to new tasks. Deep networks are suitable for parallel processing implementations and can easily leverage intensive computational resources. The course will focus on mathematical concepts, numerical algorithms, principles, GPU frameworks, and applications of deep learning. Topics include deep feedforward networks, convolutional networks, sequence modeling, and deep generative models with applications to data analysis, computer vision, and natural language processing. Several programming assignments and a project will practice the application of deep learning techniques to actual problems. The course requires sufficient math and programming background but does not require prior knowledge in machine learning.

Prerequisite(s): CS 430 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CS 578**Interactive and Transparent Machine Learning**

This course will discuss how we can enable humans and machine learning systems to interact and collaborate for more effective and accurate decision making. Topics include, but are not limited to, expert systems, recommender systems, active learning, crowdsourcing, learning with rationales, interactive machine learning, and transparency. Students are expected to delve deep into the assumptions, mathematical formulations, and algorithmic optimizations of various machine learning algorithms, read several academic papers, analyze numerous datasets, inspect implicit and explicit biases present in the analytical processes, and build an interactive and transparent machine learning system.

Prerequisite(s): CS 430 with min. grade of C and CS 422 with min. grade of C

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 with min. grade of C

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**Advanced 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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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: 3 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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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:** 1 **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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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

CSP 544**System and Network Security**

This course will be a programming-based, learn-by-doing-oriented course focused on applying foundational principles in security to real systems and networks. You will implement several real attacks and take advantage of several recreated vulnerable systems in order to understand the modern landscape of network and systems security. We will also be looking at various case studies of attacks and defense strategies, including known exploit proofs-of-concept, published papers, and documents from security agencies and cyber-security research firms.

Prerequisite(s): CS 458 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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

CSP 554**Big Data Technologies**

Big data is the area of informatics focusing on data sets whose size is beyond the ability of typical database and other software tools to capture, store, analyze, and manage. This course provides a rapid immersion into the area of big data and the technologies that have recently appeared to manage it. Students may not receive credit for both CS 554 and CSP 554.

Prerequisite(s): CS 425 with min. grade of C

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:** 1 **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.

Prerequisite(s): (CS 401 or CS 331) and CS 425 and MATH 474

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.

Prerequisite(s): CSP 571 with min. grade of C and CS 425 and (CS 584 with min. grade of C or MATH 569 with min. grade of C or MATH 564 with min. grade of C)

Lecture: 0 **Lab:** 6 **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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

CSP 584**Enterprise Web Applications**

This course discusses the architectures, technologies and techniques used in the development of the object-oriented enterprise web applications using technologies such as AJAX, Servlets, Java Server Pages, HTTP protocol, XML/HTML, Sessions/Cookies, JDBC, and Multithreading. Multitier architectures, application servers, client-server model and MVC architecture will be discussed and analyzed. The course also discusses the application architecture and the process to store the transactional data in document-oriented or relational database engines and how to connect the application servers to social media websites to collect the data for further analysis using Python/Pandas and use the results of the analysis in effective marketing campaigns, sentiment analysis, and focused advertisement.

Prerequisite(s): CS 445 with min. grade of C

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 with min. grade of C

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 487 with min. grade of C or CS 445 with min. grade of C

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 with min. grade of C

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

SCI 595**Ethics for the Health Professions**

Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.

Lecture: 1 Lab: 0 Credits: 1

Master of Artificial Intelligence

The Master of Artificial Intelligence program teaches the foundational concepts and practical skills in artificial intelligence and its subfields of machine learning, deep learning, computer vision, natural language processing, probabilistic reasoning, and data analytics. The program requires 30 credit hours of coursework in artificial intelligence, interdisciplinary applications of AI, and computer science.

Curriculum

Requirement		Credits
Minimum Credits Required		30
Maximum 400-Level Credit		10
Minimum CS/CSP Credit		18

Code	Title	Credit Hours
Artificial Intelligence Core Courses		(6)
CS 480	Introduction to Artificial Int	3
or CS 581	Advanced Artificial Intelligen	
CS 584	Machine Learning	3
or MATH 569	Statistical Learning	
Artificial Intelligence Elective Courses		(9)
Select nine credit hours from the following:		9
CS 512	Computer Vision	3
CS 577	Deep Learning	3
CS 578	Interact/Trans Mach Learning	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 585	Natural Language Processing	3
Data Processing and Analytics Course		(3)
Select three credit hours from the following:		3
CS 520	Data Integration Warehousing	3
CS 522	Advanced Data Mining	3
CS 525	Advanced Database Organization	3
CS 546	Parallel and Distributed Proc	3
CS 554	Data-Intensive Computing	3
CSP 554	Big Data Technologies	3
CSP/MATH 571	Data Preparation and Analysis	3
Interdisciplinary Elective Course		(2-3)
Select two to three credit hours from the following:		2-3
BIOL 440	Neurobiology	3
BIOL 550	Bioinformatics	3
BME 433	BME Applications of Statistics	3
BME 504	Neurobiology	2
BME 506	Comp Neurosci II: Vision	3
BME 507	Cognitive Neuroscience	2
BME 538	Neuroimaging	3
BME 545	Quantitative Neural Function	3
BUS 550	Business Statistics	3
CAE 576	UAV in Construction Projects	3
CHE/MMAE 560	Ststcl Qlty Process Control	3
COM 501	Intro to Linguistics	3
COM 584	Humanizing Technology	3
ECE 563	AI in Smart Grid	3
MATH 527	Machine Learning in Finance:	3
MATH 546	Introduction to Time Series	3

MATH 564	Applied Statistics	3
MATH 574	Bayesian Computational Stats	3
MAX 522	Predictive Analytics	3
MMAE 440	Introduction to Robotics	3
MMAE 500	Data Driven Modeling	3
MMAE 540	Robotics	3
MSF 502	Statistical Anlys in Fin Mkts	3
MSF 526	Computational Finance	3
PHIL 551	Science and Values	3
PHIL 574	Ethics in Computer Science	3
PSYC 423	Learning Theory	3
PSYC 426	Cognitive Science	3
PSYC 503	Cognitive and Affective Bases	3

Elective Courses	(9-10)
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Select 9-10 credit hours of 400-level and above CS or CSP courses. ¹	9-10
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¹ Students may also select a course from the core or interdisciplinary electives course list, provided that the course is not already being applied to another requirement.

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 with a background in computer science enrolled in the program should be able to complete the requirements in one to one-and-a-half years. Optional specializations in a number of areas are available.

Curriculum

The Master of Computer Science degree program requires a core curriculum of nine credit hours and 21 credit hours of elective courses. At least 20 credit hours must come from 500-level CS/CSP courses.

Requirement	Credits
Minimum Degree Credits	30
Minimum Core Course Credits	9
Minimum 500-Level CS/CSP Credits	20

Code	Title	Credit Hours
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 Anlys of Prgm Lang	3
CS 541	Topics in Complr Constrctn	3
CS 546	Parallel and Distributed Proc	3
CS 551	Operating Syst Design&Implemtn	3
CS 553	Cloud Computing	3
Systems Core Courses		(3)
Select a minimum of one course from the following:		3
CS 542	Computer Netwrks I:Fundamentls	3
CS 544	Computer Ntwrks II: Ntwrk Svc	3
CS 547	Wireless Networking	3
CS 550	Advanced Operating Systems	3
CS 555	Anlytc Mdls Simul Comp Syst	3
CS 570	Adv Computer Architecture	3

CS 586	Software Systems Arch	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	Dsgn and Anlys of Algorithms	3
CS 536	Science of Programming	3
CS 538	Combinatorial Optimization	3
CS 539	Game Theory: Algorithms & Apps	3
Elective Courses		(21)
Select 21 credit hours		21
Total Credit Hours		30

Notes:

- All core and specialization courses must be satisfied by courses taken at Illinois Institute of Technology. Courses transferred for credit cannot be used to satisfy core or specialization course requirements. Core course credit does apply toward the 20-credit hour requirement for CS/CSP courses.
- Elective credit may include 400- and 500-level CS and CSP courses, certain courses transferred from other departments, and up to six credit hours of accelerated courses. Interprofessional Projects (IPROs) and deficiency courses (CS 201, CS 401, CS 402, and Calculus) cannot be included. Consult the computer science department website (science.iit.edu/computer-science) for details.
- Certain specializations have program requirements different from those above. See the 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. Students must satisfy the general Master of Computer Science requirements, and complete 24 credit hours of CS/CSP courses and three specialization courses from the Stuart School of Business.

Code	Title	Credit Hours
Specialization Courses		(9)
Select a minimum of three courses from the following:		9
BUS 510	Strategy & Innovation	3
BUS 550	Business Statistics	3
MBA 501	Financial Statement Applicatio	3
MBA 502	International Trade	3
MBA 504	Analytics for Decision Making	3
MBA 506	Leadership and Organization De	3
MBA 509	Financial Management	3
MBA 511	Marketing Strategy	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. Students who have already taken Stuart School of Business courses as part of a degree program cannot reuse those courses to satisfy specialization course requirements.

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. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12

CS 480	Introduction to Artificial Int	3
CS 512	Computer Vision ¹	3
CS 522	Advanced Data Mining	3
CS 577	Deep Learning	3
CS 578	Interact/Trans Mach Learning	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

¹ CS 512 serves simultaneously as a specialization and a Programming core course.

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. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12
CS 442	Mobile Application Development	3
CS 552	Distributed Real-Time Systems	3
CS 553	Cloud Computing ¹	3
CS 555	Anlytc Mdls Simul Comp Syst ¹	3
CS 556	Cyber-Physical Sys: Lang & Sys	3
CS 557	Cyber-Physical Sys Sec/Dsgn	3
CS 558	Advanced Computer Security	3
Total Credit Hours		12

¹ CS 553 serves simultaneously as a specialization course and a Programming core course. CS 555 serves simultaneously as a specialization course and a Systems core course.

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. This program 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. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12
CS 422	Data Mining	3
CS 520	Data Integration Warehousing	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 database systems. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12
CS 425	Database Organization	3
CS 520	Data Integration Warehousing	3
CS 521	Object-Oriented Analysis/Dsgn	3
CS 522	Advanced Data Mining	3
CS 525	Advanced Database Organization ¹	3
CS 529	Information Retrieval	3
CS 553	Cloud Computing ¹	3
CS 554	Data-Intensive Computing	3
Total Credit Hours		12

¹ CS 525 and CS 553 serve simultaneously as specialization courses and Programming core courses.

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. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12
CS 451	Parallel/Distributed Computing	3
CS 546	Parallel and Distributed Proc ¹	3
CS 550	Advanced Operating Systems ¹	3
CS 552	Distributed Real-Time Systems	3
CS 553	Cloud Computing ¹	3
CS 554	Data-Intensive Computing	3
CS 570	Adv Computer Architecture ¹	3
Total Credit Hours		12

¹ CS 546 and CS 553 both serve simultaneously as specialization courses and Programming core courses. CS 550 and CS 570 both serve simultaneously as specialization courses and Systems core courses.

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 Stuart School of Business. In addition to satisfying the general Master of Computer Science degree requirements, students must complete 24 credit hours of CS/CSP courses and three specified MSF courses.

Code	Title	Credit Hours
Required Finance Courses		(9)
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/OTC Derivatives	3
MSF 506	Financial Statement Analysis	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. Students who have already taken Stuart School of Business courses as part of a degree program cannot reuse those courses to satisfy specialization course requirements.

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. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

The U.S. government's Information Assurance Courseware Evaluation (IACE) program has certified the computer science department's courses as meeting the national training standards for Information Systems Security Professionals (NSTISSI 4011) and Systems Certifiers (NSTISSI 4015). These standards describe course content for studying telecommunications security and automated information systems security.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four of the following courses:		12
CS 458	Intro to Information Security	3
CS 525	Advanced Database Organization ¹	3
CS 528	Data Privacy and Security	3
CS 549	Cryptography	3
CS 550	Advanced Operating Systems ¹	3
CS 558	Advanced Computer Security	3
CSP 544	System and Network Security	3
Total Credit Hours		12

¹ CS 525 serves simultaneously as a specialization course and a Programming core course. CS 550 serves simultaneously as a specialization course and a Systems core course.

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 theory and practice of computer networking and telecommunications. Students must satisfy general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12
CS 455	Data Communication	3
CS 542	Computer Netwrks I: Fundamentals ¹	3
CS 544	Computer Ntwrks II: Ntwrk Svc ¹	3
CS 547	Wireless Networking ¹	3
CS 548	High-Speed Networks	3
CS 549	Cryptography	3

CS 555	Anlytc Mdls Simul Comp Syst ¹	3
CS 557	Cyber-Physical Sys Sec/Dsgn	3
Total Credit Hours		12

¹ CS 542, CS 544, CS 547, and CS 555 all serve simultaneously as specialization courses and Systems core courses.

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 general Master of Computer Science requirements and complete four specialization courses.

Code	Title	Credit Hours
Specialization Courses		(12)
Select a minimum of four courses from the following:		12
CS 487	Software Engineering	3
CS 521	Object-Oriented Analysis/Dsgn	3
CS 536	Science of Programming ¹	3
CS 537	Software Metric	3
CS 586	Software Systems Arch ¹	3
CS 587	Software Project Management	3
CS 589	Software Testing and Anlys	3
Total Credit Hours		12

¹ CS 536 serves simultaneously as a specialization course and a Theory core course. CS 586 serves simultaneously as a specialization course and a Systems core course.

Master of Cybersecurity Curriculum

Requirement	Credits
Minimum Degree Credits	30
Minimum Core Course Credits	9
Minimum 500-Level CS/CSP Credits	20
Maximum 400-Level Credits	10

Code	Title	Credit Hours
Core Courses		(9)
There are three categories of core courses: Data and Information Security, Software Security, System and Network Security. As part of satisfying coursework requirements, Master of Cybersecurity students must take at least one course in each core group.		
CS 528 or CS 549	Data Privacy and Security Cryptography	3
CS 458 or CS 557	Intro to Information Security Cyber-Physical Sys Sec/Dsgn	3
CS 558 or CSP 544	Advanced Computer Security System and Network Security	3
Security Elective Courses		(9)
In addition to the core course requirement, students must also select 3 additional courses from either the security core groups or from the list of security-related course electives.		
CS 520	Data Integration Warehousing	3
CS 522	Advanced Data Mining	3
CS 525	Advanced Database Organization	3

CS 544	Computer Ntwrks II: Ntwrk Svc	3
CS 550	Advanced Operating Systems	3
CS 551	Operating Syst Design&Implemtn	3
CS 556	Cyber-Physical Sys: Lang & Sys	3
CS 559	Biometrics	3
CS 579	Online Social Network Analysis	3
CS 584	Machine Learning	3
CS 586	Software Systems Arch	3
CS 589	Software Testing and Anlys	3
General Elective Courses		(12)
Select 12 credit hours from any 400- or 500-level CS course (maximum 10 credits from 400-Level courses)		12
Total Credit Hours		30

- ¹ All core and security elective courses must be satisfied by courses taken at Illinois Institute of Technology. Only courses taken from the IIT CS department can be used as core courses; CS courses transferred from other universities can be used only as electives.
- ² Students without a prior degree in computer science may be required to take some or all of the following courses: CS 201, CS 401, CS 402, and any other necessary prerequisites. This will likely increase the duration of the degree for such students.

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 six credit hour practicum project. The program is designed primarily for those with previous degrees or experience in computer science, statistics, mathematics, the natural or social sciences, or business, and 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 analytical writing score of at least 3.0 are required. The GRE requirement may 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.

Prerequisites include knowledge of a high level programming language at the level of CS 201 (object-oriented programming is required), a data structures and algorithms course at the level of CS 331, multivariate calculus at the level of MATH 251, 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 bulletin. Proficiency and placement exams are also available.

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, nine credit hours of elective courses, and six credit hours of CSP 572/MATH 572 Data Science Practicum. At least nine credit hours must be taken of 400- or 500-level CS or CSP courses and nine credit hours of 400- or 500-level MATH courses, not including the CSP 572/MATH 572 Data Science Practicum.

Up to six credit hours of 400-level undergraduate coursework may be used toward degree requirements.

Code	Title	Credit Hours
Data Science Core Courses		(18)
MATH 563 or MATH 564	Mathematical Statistics Applied Statistics	3
CS 584 or MATH 569	Machine Learning Statistical Learning	3
SCI 511 or CS 587	Project Management Software Project Management	3
SCI 522	Public Engagement Scientists	3
CSP 571	Data Preparation and Analysis	3

Select a minimum of one course from the following:			3
CS 525	Advanced Database Organization	3	
CS 554	Data-Intensive Computing	3	
CSP 554	Big Data Technologies	3	
Data Science Capstone			(6)
CSP/MATH 572	Data Science Practicum (Summer only)	6	
Data Science Electives			(9)
Select nine credit hours of Data Science Electives			9
Total Credit Hours			33

Data Science Electives

Code	Title	Credit Hours
Computational Fundamentals		(36)
CS 425	Database Organization	3
CS 430	Introduction to Algorithms	3
CS 450	Operating Systems	3
CS 520	Data Integration Warehousing	3
CS 525	Advanced Database Organization	3
CS 528	Data Privacy and Security	3
CS 535	Dsgn and Anlys of Algorithms	3
CS 546	Parallel and Distributed Proc	3
CS 553	Cloud Computing	3
CS 554	Data-Intensive Computing	3
CS 589	Software Testing and Anlys	3
CSP 554	Big Data Technologies	3
Computer Science Applications		(39)
CS 422	Data Mining	3
CS 512	Computer Vision	3
CS 513	Geospatial Vision/Visualizatio	3
CS 522	Advanced Data Mining	3
CS 529	Information Retrieval	3
CS 556	Cyber-Physical Sys: Lang & Sys	3
CS 557	Cyber-Physical Sys Sec/Dsgn	3
CS 577	Deep Learning	3
CS 578	Interact/Trans Mach Learning	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		(48)
MATH 454	Graph Theory and Applications	3
MATH 481	Intro to Stochastic Processes	3
MATH 483	Design and Analysis of Exprmnt	3
MATH 486	Mathematical Modeling I	3
MATH 487	Mathematical Modeling II	3
MATH 522	Mathematical Modeling	3
MATH 532	Linear Algebra	3
MATH 535	Optimization I	3
MATH 540	Probability	3
MATH 542	Stochastic Processes	3
MATH 546	Introduction to Time Series	3
MATH 565	Monte Carlo Methods in Fin	3

MATH 566	Multivariate Analysis	3
MATH 567	Adv Design of Experiments	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Stats	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 Data Science Curriculum

					Year 1
Semester 1	Credit Hours	Semester 2	Credit Hours	Semester 3	Credit Hours
CS 525, 554, or CSP 554		3 CS 584 or MATH 569		3 CSP 572	6
MATH 563 or 564		3 CSP 571		3	
SCI 511 or CS 587		3 Data Science Elective		3	
		9		9	6
					Year 2
Semester 1	Credit Hours				
SCI 522		3			
Data Science Elective		3			
Data Science Elective		3			
		9			

Total Credit Hours: 33

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 five 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 or CS 535	Introduction to Algorithms Dsgn and Anlys of Algorithms	3
MATH 481 or MATH 564 or MATH 565	Intro to Stochastic Processes Applied Statistics Monte Carlo Methods in Fin	3
CS 539 or CS 584 or MBA 505 or MATH 522	Game Theory: Algorithms & Apps Machine Learning Microeconomics and Game Theory Mathematical Modeling	3
CS 538 or MATH 535	Combinatorial Optimization Optimization I	3
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	3
CS 522	Advanced Data Mining	3
CS 525	Advanced Database Organization	3
CS 529	Information Retrieval	3
CS 554	Data-Intensive Computing	3
CS 577	Deep Learning	3
CS 579	Online Social Network Analysis	3
CS 583	Probabilistic Graphical Models	3
CS 585	Natural Language Processing	3
CS 595	Topics in Computer Science	3
CS 597	Reading and Special Problems	1-3
Applied Math Electives		(3)
Select a minimum of one course from the following:		3
MATH 483	Design and Analysis of Exprmnt	3
MATH 485	Intro to Mathematical Finance	3
MATH 522	Mathematical Modeling	3
MATH 546	Introduction to Time Series	3
MATH 548	Mathematical Finance I	3
MATH 553	Discrete Applied Mathematics I	3
MATH 554	Discrete Applied Math II	3
MATH 569	Statistical Learning	3
MATH 574	Bayesian Computational Stats	3
MATH 597	Reading and Special Projects	1-3
Business and Application Electives		(3)
Select a minimum of one course from the following:		3
BUS 510	Strategy & Innovation	3
CAE 581	Algorithms in Transportation	3
MBA 504	Analytics for Decision Making	3
MBA 513	Operations & Tech Management	3
MBA 526	Supply Chain Management	3
MSC 511	Math for Mgmt Science I	3
MSC 514	Math for Mgmt Science II	3
Research		(0-5)
Select zero to five credit hours		0-5
CS 591	Reseach and Thesis M.S.	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 five 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 a project under the guidance of a faculty adviser.

Curriculum

The Master of Science in Computer Science degree program requires a core curriculum of 12 credit hours and 20 credit hours of elective courses. The plan of study must consist of at least 32 credit hours, at least 20 of which must be 500-level CS courses.

Minimum Degree Credits	32
Minimum Core Course Credits	12
Minimum 500-Level CS Credit	20

Degree Options

- **Coursework Only:** All degree requirement credit hours come from coursework.
- **Master's Project:** Elective credit hours can include up to five credit hours of master's project work (CS 597). A master's project comprises a high-quality paper submitted for publication as an article or as a technical report, or a high-quality piece of software. The software should be of distribution quality, but can be proprietary.
- **Master's Thesis:** Elective credit hours can include up to five credit hours of master's thesis work (CS 591). With adviser approval, up to three additional credit hours of CS 591 may be added. A student must successfully defend a thesis to apply CS 591 credit hours toward a degree. Students who complete both a project and a thesis can apply a maximum combined total of eight credit hours of CS 591 and CS 597 toward the degree.

Core Courses

Regardless of the degree option students are required to take four core courses from the three core areas: programming, systems, and theory. The requirement is 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.

Code	Title	Credit Hours
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 Anlys of Prgm Lang	3
CS 541	Topics in Complr Constrctn	3
CS 546	Parallel and Distributed Proc	3
CS 551	Operating Syst Design&Implemtn	3
CS 553	Cloud Computing	3
Systems Core Courses		(3)
Select a minimum of one course from the following:		3
CS 542	Computer Netwrks I:Fundamentls	3
CS 544	Computer Ntwrks II: Ntwrk Svc	3
CS 547	Wireless Networking	3
CS 550	Advanced Operating Systems	3
CS 555	Anlytc Mdls Simul Comp Syst	3
CS 570	Adv Computer Architecture	3

CS 586	Software Systems Arch	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	Dsgn and Anlys of Algorithms	3	
CS 536	Science of Programming	3	
CS 538	Combinatorial Optimization	3	
CS 539	Game Theory: Algorithms & Apps	3	
Elective Courses			(20)
Select 20 credit hours from the following:			20
CS 591	Reseach and Thesis M.S. (Master's Thesis)	0-5	
CS 597	Reading and Special Problems (Master's Project)	0-5	
400- or 500-level CS courses		15-20	
Total Credit Hours			32

Notes:

- All core courses must be satisfied by courses taken at Illinois Institute of Technology. Courses transferred for credit cannot be used to satisfy core course requirements. Core course credit hours do apply toward the 20-credit hour requirement for CS courses.
- Elective credit hours may include 400- and 500-level CS courses, certain courses transferred from other departments (pending adviser and departmental approval), and up to six credit hours of accelerated courses. CSP courses, Interprofessional Projects (IPROs), and deficiency courses (CS 201, CS 401, CS 402, and calculus) cannot be included. Consult the computer science department website (science.iit.edu/computer-science) for details.

Doctor of Philosophy in Computer Science

Credit hour requirements: 40 credit hours if entering with a Master of Science in Computer Science; 49 credit hours if entering with a master of science not in computer science; 72 credit hours if entering with a Bachelor of Science 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 require more time. 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.

Overview

To receive a Ph.D., students must meet coursework requirements and pass qualifying exams, a comprehensive exam, and a thesis defense.

Curriculum

Students in the Ph.D. program have course requirements that depend on whether they enter the program with a Master of Science in Computer Science, a master of science not in computer science, or with a Bachelor of Science in Computer Science.

Students With a Master of Science in Computer Science

Requirement	Credits
Minimum Total Credits Required	72
Maximum Transfer Credit	32
Maximum 400-Level Credit	12
500- and 600-Level Course Credit Required	15-30

Code	Title	Credit Hours
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 zero to six credit hours		0-6
Ph.D. Research		(24-36)
CS 691	Research and Thesis Ph.D.	24-36
Transfer Credit		(32)
A maximum of 32 credit hours of masters transfer credit is allowed.		32

Students With a Master of Science Not In Computer Science

Requirement	Credits
Minimum Total Credits Required	72
Maximum Transfer Credit	23
Maximum 400-Level Credit	12
Minimum 500- and 600-Level Computer Science Course Credit	24

Code	Title	Credit Hours
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	(0-9)
CS 597 Reading and Special Problems ¹	0-9
General Electives	(0-9)
Select zero to nine credit hours	0-9
Ph.D. Research	(24-33)
CS 691 Research and Thesis Ph.D. ¹	24-33
Transfer Credit	(23)
A maximum of 23 hours of masters transfer credit is allowed.	23

Students With a Bachelor of Science in Computer Science

Requirement	Credits
Minimum Credits Required	72
Maximum 400-Level Credit	12
500-Level Computer Science Course Credit Required	36-54

Code	Title	Credit Hours
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 8-26 credit hours		8-26
Ph.D. Research		(24-36)
CS 691	Research and Thesis Ph.D.	24-36

¹ At least three credit hours of CS 597 or CS 691 are required in the first year.

Notes

- To be used to satisfy requirements, courses must be passed with a grade of "B" or better. CS 401, CS 402, CS 403, CSP, and accelerated courses cannot be used. With department approval, courses may be replaced by more advanced courses.
- The 500- and 600-level electives can include credit hours from CS 595. They cannot include credit hours from CS 597, CS 691, or CS 695. With department approval, up to six credit hours may come from outside the CS department.
- A student's adviser may require other courses to be taken.

Core Courses

There are six core course areas. To meet a core requirement, a course must be taken at Illinois Institute of Technology as part of the Ph.D. program; transfer courses cannot be used.

Code	Title	Credit Hours
Group 1: Theory of Computation		(15)
CS 530	Theory of Computation	3
CS 533	Computational Geometry	3
CS 535	Dsgn and Anlys of Algorithms	3
CS 538	Combinatorial Optimization	3
CS 539	Game Theory: Algorithms & Apps	3
Group 2: Systems		(12)
CS 546	Parallel and Distributed Proc	3
CS 550	Advanced Operating Systems	3

CS 562	Virtual Machines	3
CS 570	Adv Computer Architecture	3
Group 3: Programming Languages		(12)
CS 536	Science of Programming	3
CS 540	Syntactic Anlys of Prgm Lang	3
CS 541	Topics in Complr Constrctn	3
CS 545	Distributed Computing Lndscp	3
Group 4: Networks and Security		(15)
CS 528	Data Privacy and Security	3
CS 542	Computer Netwrks I: Fundamentls	3
CS 544	Computer Ntwrks II: Ntwrk Svc	3
CS 549	Cryptography	3
CS 558	Advanced Computer Security	3
Group 5: Databases		(3)
CS 525	Advanced Database Organization	3
Group 6: Software Engineering		(3)
CS 586	Software Systems Arch	3
Group 7: Computational Intelligence		(24)
CS 512	Computer Vision	3
CS 577	Deep Learning	3
CS 578	Interact/Trans Mach Learning	3
CS 579	Online Social Network Analysis	3
CS 581	Advanced Artificial Intelligen	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: three written examinations 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. See the computer science website (science.iit.edu/computer-science) and the Examinations section (p. 563) of this bulletin for details.

Master of Science 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. In special circumstances students may petition the department for consideration.

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. See the computer science website (science.iit.edu/computer-science) and the Examinations section (p. 563) of this bulletin for details.

Thesis Defense

Each student must present an oral defense of their 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. See the computer science website (science.iit.edu/computer-science) and the Examinations section (p. 563) of this bulletin for details.

Certificate in Computational Intelligence

The Certificate in Computational Intelligence is intended for students who are interested in Artificial Intelligence and ways in which computers may learn and adapt based on data so as to solve complex problems in various areas of computer science.

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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Computational Intelligence

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 480	Introduction to Artificial Int	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

Embedded controllers with integrated sensors and networking abilities are abundant and offer numerous opportunities for modern computing applications and Internet of Things (IoT). The Certificate in Cyber-Physical Systems is intended for students who are interested in learning how to work with such systems and utilize them for real-world applications.

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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Cyber-Physical Systems

Curriculum

Code	Title	Credit Hours
Select nine credit hours of the following:		9
CS 442	Mobile Application Development	3
CS 552	Distributed Real-Time Systems	3
CS 553	Cloud Computing	3
CS 555	Anlytc Mdls Simul Comp Syst	3
CS 556	Cyber-Physical Sys: Lang & Sys	3
CS 557	Cyber-Physical Sys Sec/Dsgn	3
Total Credit Hours		9

Certificate in Data Analytics

Intelligent analysis of large amounts of data is a crucial component in numerous business applications and a crucial component in supporting business decisions. The Certificate 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.

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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Data Analytics

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 422	Data Mining	3
CS 520	Data Integration Warehousing	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

The Certificate in Database Systems is intended for students who want to increase their knowledge in the principles of design and development of 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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Database Systems

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 425	Database Organization	3
CS 520	Data Integration Warehousing	3
CS 521	Object-Oriented Analysis/Dsgn	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

The Certificate in Distributed and Cloud Computing is intended for students who are interested in learning 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.

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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Distributed and Cloud Computing

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 451	Parallel/Distributed Computing	3
CS 546	Parallel and Distributed Proc	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	Adv Computer Architecture	3

Total Credit Hours 9

Certificate in Information Security and Assurance

Information security, privacy, and information assurance are of prime importance in modern computer systems where data and systems can be accessed from nearly everywhere. The Certificate in Information Security and Assurance is intended for students interested in aspects of security and assurance in modern e-commerce applications.

The U.S. government's Information Assurance Courseware Evaluation (IACE) program has certified the computer science department's courses as meeting the national training standards for Information Systems Security Professionals (NSTISSI 4011) and Systems Certifiers (NSTISSI 4015). These standards describe course content for studying telecommunications security and automated information systems security.

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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Information Security and Assurance

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 458	Intro to Information Security	3
CS 525	Advanced Database Organization	3
CS 549	Cryptography	3
CS 558	Advanced Computer Security	3
CSP 544	System and Network Security	3

Total Credit Hours 9

Certificate in Networking and Communications

The Certificate in Networking and Communications is designed for individuals who want to increase their knowledge and skills in the theory and practice of computer 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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Networking and Communications

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 455	Data Communication	3
CS 542	Computer Netwrks I: Fundamentals	3
CS 544	Computer Ntwrks II: Ntwrk Svc	3
CS 547	Wireless Networking	3
CS 548	High-Speed Networks	3
CS 549	Cryptography	3
CS 555	Anlytc Mdls Simul Comp Syst	3

Total Credit Hours 9

Certificate in Software Engineering

The Certificate in Software Engineering is intended for students who want to increase their knowledge and skills in software design, development, and maintenance.

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 nine credit hours of coursework is completed with a GPA of 3.0/4.0. Courses taken may be later applied toward a computer science master's degree program.

Gainful Employment Disclosure for Certificate in Software Engineering

Curriculum

Code	Title	Credit Hours
Select nine credit hours from the following:		9
CS 487	Software Engineering	3
CS 521	Object-Oriented Analysis/Dsgn	3
CS 536	Science of Programming	3
CS 537	Software Metric	3
CS 586	Software Systems Arch	3
CS 587	Software Project Management	3
CS 589	Software Testing and Anlys	3
Total Credit Hours		9

Industrial Technology and Management

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Director

Mazin Safar

Director of Operations

Pamela Houser

Faculty Research/Student Projects

For information on faculty and student research projects, visit the Industrial Technology and Management website.

Industrial Technology and Management (INTM) programs provide students with a broad knowledge of industrial technologies and operational activities, and the managerial and communication skills required to effectively manage operations, personnel, and resources in a competitive, performance-oriented industrial environment. Emphasis is on the range of competencies required for an individual to successfully function in a managerial, supervisory, or staff position in industry, and their ability to provide practical solutions to complex situations.

The Master of Industrial Technology and Operations (MITO) is a ten-course STEM (Science, Technology, Engineering, and Math) degree which allows students to pursue a program of study suited to their professional interests and career objectives. INTM courses focus on functional activities and managerial skills, utilization of current and emerging technologies, and the development of critical thinking and innovative problem-solving abilities. In-depth study of industry-specific topics is achieved through the completion of an industrial specialization, options for which include:

- Construction Technology (CT)
- Facilities Management (FM)
- Industrial Sustainability (ST)
- Manufacturing Technology (MT)
- Supply Chain Management (SCM)

The MITO program may be completed on a full-time or part-time basis. INTM courses generally meet one night a week to suit the schedules of working adults. Classes meet at Illinois Institute of Technology's Mies Campus in Chicago, and may be taken online by students with time constraints or who are located elsewhere in the world.

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. 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 need to improve their managerial skills and expand their understanding of industrial operations and applied technologies. 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. 337)

Course Descriptions

INTM 502

Industrial Engineering Concepts and Applications

Beginning with productivity and productivity improvement, students learn Industrial Engineering concepts and are trained to apply them to optimize engineering and operational tasks. Topics covered include time and motion studies, work measurement, ergonomics, value stream engineering, and value stream mapping. Data envelopment analysis and analytical hierarchy process are implemented, using Excel to optimize operations. Plant location selection and layout are covered. Students learn to optimize project selection using ROI and other metrics and execute projects using Microsoft Project. An open source ERP system is used to illustrate MRP and other planning functions. The application of statistical methods, including hypothesis testing, to improve performance is also covered.

Lecture: 3 Lab: 0 Credits: 3

INTM 505

Maintenance Technology and Management

Maintenance of facilities and building systems is a major concern for all industrial operations. Facility managers must maintain heating, ventilation, air conditioning, plumbing, fire-life safety, electrical and other building systems, many of which are interrelated. Dysfunction in one system can cause problems in another, leading to occupant discomfort, poor energy efficiency and premature equipment failure. Equipment maintenance techniques have evolved to include more scientific diagnosis for increased uptime reliability. Preventive, predictive and prescriptive maintenance command a high percentage of modern behaviors to keep facilities running at peak efficiency. This course blends both the technical and managerial sides of maintenance with a focus on procedural analysis.

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

This course introduces accounting information used for decision-making within a business enterprise. Financial reporting, financial terminology, and the three major financial statements are reviewed. Product costing, short-term and long-term decision-making, budgeting, control of operations, and performance evaluations are covered as are cost-volume-profit relationships, relevant costs, flexible budgets, and standard costs.

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 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 the processes and tools needed to successfully manage new construction and renovation projects, building systems improvements, ongoing facilities management functions, and integration of new technologies within buildings and infrastructure. Students learn to assess facilities projects, develop project scope, plan for implementation, and create a project team. Explores real world successes and failures in buildings, equipment and technologies. Coursework focuses on completion of a comprehensive project, from conceptualization to development and implementation, inclusive of costing, team building and creating a pitch for project funding to upper management.

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**Modeling for Decision-Making**

Management Information Systems (MIS) are utilized in all industrial sectors to manage, analyze, and optimize operational processes. This course examines the integration of MIS for a range of operational activities, including production scheduling, inventory control, purchasing, shipping, and invoicing. Students will be exposed to the theory of MIS by reviewing case studies and successful applications. Students learn how to build spreadsheet models for multiple business problems using linear programming (LP) and integer programming (IP) and perform regression analysis and basic time series forecasting. A variety of Microsoft Excel tools are introduced.

Lecture: 3 Lab: 0 Credits: 3

INTM 523**Sustainable Facilities Operations**

Maintaining and managing buildings and facilities is a challenging, multifaceted occupation. Facilities are becoming smarter and greener as the goals of energy conservation and occupant comfort have shifted to include environmental responsibility. This course examines facility operations and management (O&M) related to sustainability and green technology, with an emphasis on the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) requirements, rating system, and the process for properties to apply for certification as a resource-efficient operation.

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 534**Manufacturing 4.0**

This course focuses on the Fourth Industrial Revolution (Industry 4.0) and the major manufacturing technologies that must be integrated and implemented effectively in a timely manner in order to sustain a competitive advantage. Advanced in product design, breakthrough achievements in materials used in products, and reduced time to market require the use of advanced industrial processes to maximize customer service and company profitability. Topics include: shaping the fourth industrial revolution, manufacturing 4.0, manufacturing economics, manufacturing analytics, supply chain 4.0, quality 4.0, Industrial Internet of Things (IIoT), future of manufacturing skills, advanced manufacturing (digital, automated, additive), AI, augmented reality, modern manufacturing leadership, and change management.

Lecture: 3 Lab: 0 Credits: 3

INTM 535**Performance Management in Food Operations**

Creating an organization-wide culture of quality and performance is critical to managing the unique demands of a food processing company. Learn how to develop, manage, and improve food production processes, implement lean principles to eliminate waste and improve yields, and measure operational performance. Topics covered include budgeting and financial tools, introducing new food products and processes, Total Quality Management (TQM), evaluation and management of supply chain activities, and strategy deployment techniques.

Lecture: 3 Lab: 0 Credits: 3

INTM 537**Smart Factory Automation**

Technology changes how companies operate, impacting internal processes and how comprehensive manufacturing solutions are established to serve customer needs. The challenge lies in connecting independent processes into systems that are reliable, self-adjusting, and communicate in real time. Internal systems must successfully blend hardware, software, sensors and codes, and integrate new technologies to automate, assess and control manufacturing operations. The goal is to achieve a transparent system with faster processing times, fewer interruptions and a more continuous flow, resulting in competitive advantage throughout the entire value stream. This course covers interconnection, optimization and automation of processes to achieve competitive advantage in manufacturing operations.

Lecture: 3 Lab: 0 Credits: 3

INTM 538**Advanced Metals Manufacturing I**

Today's leading edge manufacturing environment has advanced technology and systems embedded throughout its framework. This course exposes students to the functional aspects and capabilities of a 5-axis CNC machining center, and the processes involved in taking a machined part from prototype to production. This state-of-the-art technology is used by high-production companies around the world to create complex, precision-machined parts and products with tight tolerances and extreme repeatability. Students gain experience using SinuTrain simulators and hands-on learning on a 5-axis CNC machine. Coverage includes CNC programming and use of IIoT system technologies embedded in the machine to obtain internal diagnostics with real time data and connect with internal departments, suppliers and customers. Prior completion of a course in manufacturing processes highly recommended. First course in a two-course sequence.

Lecture: 2 Lab: 2 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**

Provides an overview of manufacturing, logistics and supply chain management (SCM) information systems and software packages, as well as practical tools and techniques for effective decision making. Emphasis on the importance of accurate and timely data, efficient business processes, and utilizing state-of-the-art information tools and technologies. Students gain hands-on experience using a modern ERP system to understand the features, functionality, and end-to-end dependencies of the core ERP modules used in an enterprise.

Prerequisite(s): INTM 441 with min. grade of C or INTM 540 with min. grade of C

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 with min. grade of C or INTM 540 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

INTM 548**Agile Methodologies for New Product/Process Development**

The development of new products and operational processes in a manufacturing setting requires collaboration and teamwork across multiple departments and flexible (agile) methods to expediently assess product/process viability and implement production without interrupting current operations. This course explores agile methodologies and management strategies involved in developing a new product or process, to include innovation and design, environmental concerns, market analysis, timing, budgets, collaborative strategies, patents and trade secrets, licensing and distribution, and marketing/pricing.

Lecture: 3 Lab: 0 Credits: 3

INTM 550**Demand Planning and Forecasting**

Foundations, methodologies and strategies of demand management, planning and forecasting. Course covers the range of factors that influence, shape and control demand, digitization of the supply chain, use of technology and big data, forecasting techniques and performance metrics.

Lecture: 3 Lab: 0 Credits: 3

INTM 551**Data Analytics for Industry**

Organizations of all types employ rigorous analysis of vast amounts of internal and external data to improve the quality of decision making. This course prepares students to define and organize data, perform exploratory analysis, and select and implement analytical models, with a focus on applications in the areas of operations and marketing. Excel plugins, statistical packages (R, SAS or SPSS), and business intelligence products like Tableau will be used extensively for modeling. The course covers descriptive and inferential statistics, principles of design of experiments and analysis of variance (ANOVA), and supervised and unsupervised learning methods including regression, classification and clustering. Prior completion of a course in elementary probability and statistics highly recommended.

Prerequisite(s): INTM 502 with min. grade of C or INTM 522 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 Critical Matrls**

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: 3 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

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 managerial, supervisory, and staff positions in industry. Considered to be a hybrid degree, the MITO blends practical application of current technologies with the managerial 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.

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 six credit hours may be applied from special project courses (INTM 597) or an Interprofessional Project (IPRO 497). A total of nine 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 five concentrations within the INTM curriculum: Construction Technology (CT), Facilities Management (FM), 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 are available 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. The MITO program can be completed entirely online.

Curriculum

Code	Title	Credit Hours
Elective Courses		(18-30)
Select a minimum of 18-30 credit hours from the following: ¹		18-30
INTM 404	Marketing, Sales, & Prod Intro	3
INTM 406	Quality Management Systems	3
INTM 410	Operations Management	3
INTM 411	Functional Facilities Mgmt	3
INTM 413	Contract Admn for Construction	3
INTM 417	Construction Estimating	3
INTM 425	Human Resrcs Management	3
INTM 427	E-Commerce in Mkt/Supply Chain	3
INTM 432	Sales and Operations Planning	3
INTM 436	Lean Manufacturing	3
INTM 477	Entrepreneurship Industry	3
INTM 502	Ind Engg Concepts/Applications	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 Mgmt	3
INTM 518	Industrial Risk Management	3
INTM 520	Appl Strat for Competitive Ent	3
INTM 522	Modeling for Decision-Making	3
INTM 523	Sustainable Facilities Ops	3
INTM 530	Transportation	3
INTM 534	Manufacturing 4.0	3
INTM 535	Perf Mgmt in Food Operations	3

INTM 537	Smart Factory Automation	3
INTM 538	Advanced Metals Mfg I	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 Intrntl Business	3
INTM 546	Manufacturing & Logistics Info	3
INTM 547	Supply Chain Strategies	3
INTM 550	Demand Planning & Forecasting	3
INTM 551	Data Analytics for Industry	3
INTM 559	Issues in Ind Sustainability	3
INTM 560	Sustainability Critical Matrls	3
INTM 561	Energy Options in Industry	3
INTM 597	Special Projects ²	1-4
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 six 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

Five industrial specializations are available. To earn a specialization, the student must complete four courses within an identified focus area.

Construction Technology (CT)

Code	Title	Credit Hours
INTM 413	Contract Admn for Construction	3
INTM 417	Construction Estimating	3
INTM 507	Construction Technology	3
INTM 515	Advanced Project Management	3
Total Credit Hours		12

Facilities Management (FM)

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
INTM 411	Functional Facilities Mgmt	3
INTM 413	Contract Admn for Construction	3
INTM 505	Maintenance Tech and Mgmt	3
INTM 515	Advanced Project Management	3
INTM 516	Integrated Facilities Mgmt	3
INTM 523	Sustainable Facilities Ops	3
Total Credit Hours		12

Industrial Sustainability (ST)

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
INTM 523	Sustainable Facilities Ops	3
INTM 559	Issues in Ind Sustainability	3
INTM 560	Sustainability Critical Matrls	3
INTM 561	Energy Options in Industry	3

INTM 562	Special Topics Sustainability	3
Total Credit Hours		12

Manufacturing Technology (MT)

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
INTM 406	Quality Management Systems	3
INTM 436	Lean Manufacturing	3
INTM 534	Manufacturing 4.0	3
INTM 535	Perf Mgmt in Food Operations	3
INTM 537	Smart Factory Automation	3
INTM 538	Advanced Metals Mfg I	3
INTM 546	Manufacturing & Logistics Info	3
Total Credit Hours		12

Supply Chain Management (SCM)

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
INTM 427	E-Commerce in Mkt/Supply Chain	3
INTM 432	Sales and Operations Planning	3
INTM 509	Inventory Control	3
INTM 530	Transportation	3
INTM 542	Warehousing and Distribution	3
INTM 543	Purchasing	3
INTM 544	Export/Import	3
INTM 546	Manufacturing & Logistics Info	3
INTM 547	Supply Chain Strategies	3
INTM 550	Demand Planning & Forecasting	3
Total Credit Hours		12

Information Technology and Management

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Daniel F. and Ada L. Rice Campus
201 E. Loop Rd.
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630.682.6000

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 cybersecurity 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 cybersecurity 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 (C²SAFE) 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. 573) in this bulletin.

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 to a professional masters degree 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 the Graduate Admission section (p. 11)). Admission as a non-degree student follows the university policy set forth in this bulletin.

Applicants for admission to a master of science degree should hold a four-year bachelor's degree in a computing or computing-related engineering discipline from an accredited institution with a minimum cumulative undergraduate GPA of 3.0/4.0 and minimum GRE score of 305 (combined quantitative and verbal), 151 quantitative, and 3.0 analytical writing; international applicants may be required to submit a TOEFL score (see the Graduate Admission section (p. 11)). Applicants admitted to a master of science degree who do not hold a four-year bachelor's degree in a computing or computing-related engineering discipline may be required to complete up to one year of prerequisite courses prior to beginning formal graduate studies.

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 ITM 313 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. Students enrolled in undergraduate post-baccalaureate studies (see the Graduate Admission section (p. 11)) 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 540); and the ability to create and administer databases using a modern database management system.

Current prerequisites for the Master of Science in Applied Cybersecurity and Digital Forensics 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 540); the ability to create and administer databases using a modern database management system; and completion of a program of mathematics culminating in a calculus-based course in probability and statistics (MATH 474).

Current prerequisites for the Master of Science in 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 competent level using a contemporary programming language (ITMD 411 or ITMD 510); basic knowledge of HTML, CSS, and JavaScript (ITMD 361); the ability to create and administer databases using a modern database management system; and completion of a program of mathematics culminating in a calculus-based course in probability and statistics (MATH 474).

Degrees Offered

- Master of Cyber Forensics and Security (p. 353)
- Master of Information Technology and Management (p. 354)
- Master of Science in Applied Cybersecurity and Digital Forensics (p. 361)
- Master of Science in Information Technology and Management (p. 363)

Certificate Programs

- Advanced Software Development (p. 366)
- Cyber Security Management (p. 366)
- Cyber Security Technologies (p. 367)
- Data Center Operations and Management (p. 367)
- Digital Voice and Data Communication Technologies (p. 368)
- Information Technology Innovation, Leadership, and Entrepreneurship (p. 368)
- System Administration (p. 369)
- Systems Analysis (p. 369)
- Web Design and Application Development (p. 370)

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 client interfaces. 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: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

ITMD 514

Programming for Data Analytics

This course will introduce essential programming concepts and techniques used in analytics. Students will learn and make use of industry standard programming languages widely used in application programming for data and statistical analysis as well as other purposes. Students will understand and use various libraries for data manipulation, preparation, and analysis, and will be equipped to use the programming languages covered in real world scenarios and circumstances upon completion.

Lecture: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

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.

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 with min. grade of C

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 with min. grade of C or ITMD 512 with min. grade of C or ITMD 515 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C and ITMO 556 with min. grade of C and ITMO 540 with min. grade of C

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: 3 Lab: 0 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: 3 Lab: 0 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: 3 Lab: 0 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 with min. grade of C or ITMD 554 with min. grade of C or ITMD 555 with min. grade of C

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: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

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: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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 565 with min. grade of C and ITMD 562 with min. grade of C

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**Vendor Management and 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.

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 Management 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.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 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: 3 Lab: 0 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 with min. grade of C

Lecture: 3 Lab: 0 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): ITMO 556 with min. grade of C and ITMD 510 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

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: 3 Lab: 0 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 556 with min. grade of C and ITMO 540 with min. grade of C

Lecture: 3 Lab: 0 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 with min. grade of C

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 514**Programming for Cybersecurity Analytics**

This course will introduce essential programming concepts and techniques used in analytics. Students will learn and make use of industry standard programming languages widely used in application programming for data and statistical analysis in cybersecurity as well as other purposes. Students will understand and use various libraries for data manipulation, preparation, and analysis, and will be equipped to use the programming languages covered in real world scenarios and circumstances upon completion.

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 with min. grade of C or ITMD 512 with min. grade of C or ITMD 515 with min. grade of C

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 with min. grade of C or ITMS 548 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 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 be extended into a full operational security system in a follow-course,

Prerequisite(s): ITMO 540 with min. grade of C

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 with min. grade of C and ITMS 548 with min. grade of C

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 583**Digital Evidence**

In this course, students learn the fundamental principles and concepts in the conduct of investigations in the digital realm. Students will learn the process and methods of obtaining, preserving and presenting digital information for use as evidence in civil, criminal, or administrative cases. Topics include legal concepts and terminology, ethics, computer crime, investigative procedures, chain of custody, digital evidence controls, processing crime and incident scenes, data acquisition, e-mail investigations, applicable case law, and appearance as an expert witness in a judicial or administrative proceeding.

Prerequisite(s): ITMS 538 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

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 with min. grade of C

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 teams 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 with min. grade of C

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 with min. grade of C

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 591**Independent Study and Research**

Research and Thesis for Masters' degrees. Instructor permission required.

Credit: Variable

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.

Master of Cyber Forensics and Security (Coursework Only Option)

Code	Title	Credit Hours
Required Core Courses		(18) ¹
ITMS 538	Cyber Forensics	3
ITMS 543	Vulnerability Analys and Ctrl	3
ITMS 548	Cyber Security Technologies	3
ITMS 578	Cyber Security Mgmt	3
ITMS 583	Digital Evidence	3
ITMM 585	Lgl&Ethical Issu In Info Tech	3
Elective Courses		(12)
Select a minimum of 12 credit hours from the following:		12
Any 500-level ITMS course not listed in required courses above. ^{2, 3}		
ITMM 586	IT Auditing	3
ITMO 556	Intro to Open Source Software	3
ITMT 597	Special Problem in IT ⁴	3
Total Credit Hours		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 Students pursuing the coursework only option may not choose ITMS 549 as an elective course.

³ ITMS 579 may be taken more than once.

⁴ A maximum of six credit hours of ITMT 597 may be used toward degree requirements.

Master of Cyber Forensics and Security (Master's Project Option)

Code	Title	Credit Hours
Required Core Courses		(21) ¹
ITMS 538	Cyber Forensics	3
ITMS 539	Steganography	3
or ITMS 549	CST: Projects & Adv Methods	
ITMS 543	Vulnerability Analys and Ctrl	3
ITMS 548	Cyber Security Technologies ²	3
ITMS 578	Cyber Security Mgmt	3
ITMS 583	Digital Evidence	3
ITMM 585	Lgl&Ethical Issu In Info Tech	3
Research Course		(3)
ITMT 594	Special Projects in IT	3
or ITMT 597	Special Problem in IT	

Elective Courses	(6)
Select a minimum of six credit hours from the following:	6
Any 500-level ITMS course not listed in required courses above. ³	
ITMM 586 IT Auditing	3
ITMO 556 Intro to Open Source Software	3
ITMT 597 Special Problem in IT ⁴	3
Total Credit Hours	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 Students electing the project option must complete ITMS 548 Cyber Security Technologies in a live section with a project component.

³ ITMS 579 may be taken more than once.

⁴ A maximum of six credit hours of ITMT 597 may be used toward degree requirements.

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 which are included as a part of each program specialization. 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 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 and Management (without Specialization)

Code	Title	Credit Hours
Programming		(3)
Select three credit hours of Programming courses		3
Application Development		(3)
Select three credit hours of Application Development courses		3
Information Systems Technologies		(3)
Select three credit hours of Information Systems Technologies courses		3
Information Technology Architectures		(3)
Select three credit hours of Information Technology Architectures courses		3
Design		(3)
Select three credit hours of Design courses		3
Management		(3)
Select three credit hours of Management courses		3
Innovation		(3)
Select three credit hours of Innovation courses		3
Elective Courses		(9)
Select nine credit hours		9
Total Credit Hours		30

Master of Information Technology and Management (with Specialization)

Code	Title	Credit Hours
Specialization Courses		(24)
Select 24 credit hours from approved core and specialization courses ¹		24
Elective Courses		(6)
Select six credit hours		6
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. The three required core courses are included in each program specialization.

Graduate Core Courses by Subject and Topic

The following courses comprise the graduate core courses:

Subject: Software Development

Topic: Programming

Code	Title	Credit Hours
ITMD 510	Object-Oriented App Develop	3
ITMD 512	Structured/Systems Programming	3
ITMD 514	Programming for Data Analytics	3
ITMD 515	Advanced Software Programming	3
ITMS 514	Prgmring for Cyber Analytics	3

Subject: System Technologies

Topic: Application Development

Code	Title	Credit Hours
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 565	Rich Internet Applications	3
ITMD 566	Service-Oriented Architectures	3
ITMT 593	Embedded Systems	3

Topic: Information Systems Technologies

Code	Title	Credit Hours
ITMO 533	Enterprise Server Admin	3
ITMO 553	Open Source System Admin	3
ITMO 556	Intro to Open Source Software	3
ITMS 558	Operating Systems Security	3

Topic: Information Technology Architectures

Code	Title	Credit Hours
ITMO 540	Intro Data Networks & Internet	3
ITMO 554	Operating Sys Virtualization	3
ITMS 548	Cyber Security Technologies	3
ITMT 535	Data Center Architecture	3

Subject: Business Development

Topic: Design

Code	Title	Credit Hours
ITMD 511	Application Dev Methodologies	3
ITMD 532	UML-Based Software Development	3
ITMD 534	Human/Computer Interaction	3
ITMT 531	OO Syst Anlys Mod & Des	3

Topic: Management

Code	Title	Credit Hours
ITMM 537	Vendor Mgmt/Service Lvl Agrmts	3
ITMM 570	Fund of Mgmt for Tech Prof	3
ITMM 571	Project Management for ITM	3
ITMM 574	ITM Frameworks	3
ITMM 575	Networking/Telecom Management	3
ITMS 578	Cyber Security Mgmt	3

Topic: Innovation

Code	Title	Credit Hours
ITMM 581	IT Entrepreneurship	3
ITMM 582	Business Innovation	3
ITMD 535	Human-Computer Interaction Des	3

Specializations

Computer and Information Security

Code	Title	Credit Hours
Required Courses		(24)
ITMO 540	Intro Data Networks & Internet	3
ITMO 556	Intro to Open Source Software	3
ITMS 514	Prgrmming for Cyber Analytics	3
ITMS 548	Cyber Security Technologies	3
ITMS 578	Cyber Security Mgmt	3
Select six credit hours from the following:		6
Any 500-level ITMS elective ¹		6
Select three credit hours from the following:		3
Any 500-level ITMO elective		3
Any 500-level ITMS elective		3
ITMM 586	IT Auditing	3
Total Credit Hours		24

¹ ITMS 579 may only be taken once as part of this requirement

Data Analytics and Management

Code	Title	Credit Hours
Required Courses		(24)
ITMD 514	Programming for Data Analytics (Programming for Data Analytics)	3
ITMD 523	Adv Topics in Data Management	3
ITMD 526	Data Warehousing	3
ITMD 527	Data Analytics	3
ITMS 528	Database Security	3
ITMT 531	OO Syst Anlys Mod & Des	3
Select three credit hours from the following:		3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 565	Rich Internet Applications	3
ITMD 566	Service-Oriented Architectures	3
ITMT 593	Embedded Systems	3
Select three credit hours from the following:		3
ITMD 515	Advanced Software Programming	3
ITMD 521	Client/Server Technqs & Applct	3
ITMD 525	Topics in Data Science & Mgmt	3
ITMD 529	Advanced Data Analytics	3
ITMD 566	Service-Oriented Architectures	3
ITMM 537	Vendor Mgmt/Service Lvl Agrmts	3
ITMM 574	ITM Frameworks	3
ITMO 557	Storage Technologies	3
ITMS 578	Cyber Security Mgmt	3
Total Credit Hours		24

Information Technology Infrastructure

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMO 540	Intro Data Networks & Internet	3
ITMO 556	Intro to Open Source Software	3
Select three credit hours from the following:		3
ITMM 537	Vendor Mgmt/Service Lvl Agrmts	3
ITMM 571	Project Management for ITM	3
ITMM 574	ITM Frameworks	3
ITMM 575	Networking/Telecom Management	3
ITMS 578	Cyber Security Mgmt	3
Select 12 credit hours from the following:		12
ITMD 545	Web Real-Time Communications	3
ITMD 565	Rich Internet Applications	3
ITMM 576	Data Center Management	3
ITMO 517	Shell Scripting for Sys Admin	3
ITMO 533	Enterprise Server Admin	3
ITMO 541	Network Admin & Operations	3
ITMO 542	Wireless Technologies & Apps	3
ITMO 544	Cloud Computing Technologies	3
ITMO 546	Telecomm Over Data Networks	3
ITMO 547	Projects & Advanced Methods	3
ITMO 550	Enterprise End-User Sys Admin	3
ITMO 553	Open Source System Admin	3
ITMO 554	Operating Sys Virtualization	3
ITMO 557	Storage Technologies	3
ITMS 558	Operating Systems Security	3
ITMS 588	Incdnt Rspnse Disaster Rcvry	3
ITMT 535	Data Center Architecture	3
Total Credit Hours		24

IT Management and Entrepreneurship

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMD 534	Human/Computer Interaction	3
ITMM 570	Fund of Mgmt for Tech Prof	3
ITMM 581	IT Entrepreneurship	3
ITMM 582	Business Innovation	3
Select three credit hours from the following:		3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
Select six credit hours from the following:		6
Any 500-level ITMM elective		
ITMD 556	Intelligent Device Projects	3
ITMS 578	Cyber Security Mgmt	3
TECH 565	Intro to Social Commerce	3
TECH 581	Consulting for Technical Prof	3
Total Credit Hours		24

Management Information Systems

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMD 521	Client/Server Techngs & Applct	3
ITMD 523	Adv Topics in Data Management	3
ITMD 566	Service-Oriented Architectures	3
ITMM 574	ITM Frameworks	3
Select six credit hours from the following:		6
ITMM 537	Vendor Mgmt/Service Lvl Agrmts	3
ITMM 572	Process Engrng for IT Managers	3
ITMM 586	IT Auditing	3
ITMO 554	Operating Sys Virtualization	3
ITMT 531	OO Syst Anlys Mod & Des	3
Select three credit hours from the following:		3
INTM 522	Modeling for Decision-Making	3
ITMD 515	Advanced Software Programming	3
ITMD 525	Topics in Data Science & Mgmt	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	Vendor Mgmt/Service Lvl Agrmts	3
ITMO 544	Cloud Computing Technologies	3
ITMO 557	Storage Technologies	3
ITMS 528	Database Security	3
TECH 565	Intro to Social Commerce	3
TECH 581	Consulting for Technical Prof	3
Total Credit Hours		24

Smart Technology and Innovation

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMD 556	Intelligent Device Projects	3
ITMM 582	Business Innovation	3
ITMO 556	Intro to Open Source Software	3
ITMT 593	Embedded Systems	3
Select three credit hours from the following:		3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
Select three credit hours from the following:		3
ITMD 511	Application Dev Methodologies	3
ITMD 556	Intelligent Device Projects	3
ITMO 542	Wireless Technologies & Apps	3
ITMO 544	Cloud Computing Technologies	3
Select three credit hours from the following:		3
ITMD 545	Web Real-Time Communications	3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3

ITMD 556	Intelligent Device Projects	3
ITMD 565	Rich Internet Applications	3
ITMO 540	Intro Data Networks & Internet	3
ITMO 541	Network Admin & Operations	3
ITMO 546	Telecomm Over Data Networks	3
INTM 522	Modeling for Decision-Making	3
TECH 565	Intro to Social Commerce	3
Total Credit Hours		24

Software Development

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMD 515	Advanced Software Programming	3
ITMD 536	Software Testing & Maintenance	3
ITMD 565	Rich Internet Applications	3
ITMM 571	Project Management for ITM	3
Select three credit hours from the following:		3
ITMD 511	Application Dev Methodologies	3
ITMD 513	Open Source Programming	3
ITMD 532	UML-Based Software Development	3
Select six credit hours from the following:		6
ITMD 511	Application Dev Methodologies	3
ITMD 512	Structured/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/Computer Interaction	3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 556	Intelligent Device Projects	3
ITMD 565	Rich Internet Applications	3
ITMM 572	Process Engrng for IT Managers	3
ITMS 518	Coding Security	3
ITMT 531	OO Syst Anlys Mod & Des	3
TECH 565	Intro to Social Commerce	3
Total Credit Hours		24

Systems Analysis

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMD 511	Application Dev Methodologies	3
ITMD 534	Human/Computer Interaction	3
ITMD 536	Software Testing & Maintenance	3
ITMM 572	Process Engrng for IT Managers	3
ITMT 531	OO Syst Anlys Mod & Des	3
Select three credit hours from the following:		3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3

ITMD 565	Rich Internet Applications	3
Select three credit hours from the following:		3
INTM 522	Modeling for Decision-Making	3
ITMD 532	UML-Based Software Development	3
ITMM 574	ITM Frameworks	3
ITMM 575	Networking/Telecom Management	3
ITMM 586	IT Auditing	3
ITMS 578	Cyber Security Mgmt	3
TECH 581	Consulting for Technical Prof	3
Total Credit Hours		24

Web Design and Application Development

Code	Title	Credit Hours
Required Courses		(24)
ITMD 510	Object-Oriented App Develop	3
ITMD 534	Human/Computer Interaction	3
ITMD 562	Web Site App Development	3
ITMD 565	Rich Internet Applications	3
ITMD 567	Web Systems Integration	3
ITMM 582	Business Innovation	3
Select six credit hours from the following:		6
COM 525	User Experience Research/Eval	3
ITMD 511	Application Dev Methodologies	3
ITMD 513	Open Source Programming	3
ITMD 515	Advanced Software Programming	3
ITMD 519	Topics in Software Development	3
ITMD 545	Web Real-Time Communications	3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 563	Intermediate Web App Dev	3
ITMD 564	Adv Web Site App Development	3
ITMD 566	Service-Oriented Architectures	3
ITMD 569	Topics in Application Devlmpnt	3
TECH 565	Intro to Social Commerce	3
Total Credit Hours		24

Master of Science in Applied Cybersecurity and Digital Forensics

At the conclusion of their studies, graduates of the Master of Science in Applied Cybersecurity and Digital Forensics 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
- Conduct and report on significant research in the areas of cybersecurity and/or digital forensics

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 Corps® Scholarship for

Service Program. This designation reflects Illinois Institute of Technology's commitment to producing professionals with cyber defense expertise for the nation.

Students may choose from two research options to complete the degree:

Thesis Option

The thesis option requires coursework and six credit hours ITMT 591 for a total of 32 credit hours. The result is a master's thesis.

Master's Project Option

The master's project option requires coursework and three credit hours of ITMT 594 or ITMT 597 for a total of 32 credit hours. The result is a project that results in one of the following:

1. A paper submitted for publication as an article or as a technical report
2. A security or forensic software product
3. A security hardware device or appliance

Software or hardware must have an accompanying technical report and user documentation.

Master of Science in Applied Cybersecurity and Digital Forensics (Thesis Option)

Code	Title	Credit Hours
Required Core Courses		(15) ¹
ITMS 538	Cyber Forensics	3
ITMS 543	Vulnerability Analys and Ctrl	3
ITMS 548	Cyber Security Technologies	3
ITMS 578	Cyber Security Mgmt	3
LAW 273	Evidence	3
Research Course		(6-8)
ITMT 591	Independent Study/Research	6-8
Elective Courses		(9-11)
Select seven to nine credit hours from the following:		7-9
Any 500-level ITMS course not listed in the required courses above. ²		3
ITMM 585	Lgl&Ethical Issu In Info Tech	3
ITMM 586	IT Auditing	3
ITMO 556	Intro to Open Source Software	3
ITMT 597	Special Problem in IT	3
Select a minimum of two credit hours from the following: ³		2
LAW 240	National Security Law	2
LAW 495	Electronic Discovery	2

Minimum degree credits required: 32

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 or ITMS electives may be substituted as approved by the student's adviser or the ITM associate chair.

Master of Science in Applied Cybersecurity and Digital Forensics (Master's Project Option)

Code	Title	Credit Hours
Required Core Courses		(18) ¹
ITMS 538	Cyber Forensics	3
ITMS 539	Steganography	3
or ITMS 549	CST: Projects & Adv Methods	
ITMS 543	Vulnerability Analys and Ctrl	3
ITMS 548	Cyber Security Technologies	3

ITMS 578	Cyber Security Mgmt	3
LAW 273	Evidence	3
Research Course		(3)
ITMT 594	Special Projects in IT	3
or ITMT 597	Special Problem in IT	
Elective Courses		(11)
Select a minimum of nine credit hours from the following:		9
Any 500-level ITMS course not listed in the required courses above. ²		3
ITMM 585	Lgl&Ethical Issu In Info Tech	3
ITMM 586	IT Auditing	3
ITMO 556	Intro to Open Source Software	3
ITMT 597	Special Problem in IT	3
Select a minimum of two credit hours from the following: ³		2
LAW 240	National Security Law	2
LAW 495	Electronic Discovery	2
Total Credit Hours		32

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 or ITMS electives may be substituted as approved by the student's adviser or the ITM associate chair.

Master of Science in Information Technology and Management

Master of Science in Information Technology and Management (Thesis Option)

Code	Title	Credit Hours
Core Courses		(9)
Select a minimum of three credit hours from Software Development:		3
ITMD 510	Object-Oriented App Develop	3
ITMD 512	Structured/Systems Programming	3
ITMD 513	Open Source Programming	3
ITMD 515	Advanced Software Programming	3
Select a minimum of three credit hours from System Technologies:		3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 565	Rich Internet Applications	3
ITMD 566	Service-Oriented Architectures	3
ITMO 533	Enterprise Server Admin	3
ITMO 540	Intro Data Networks & Internet	3
ITMO 553	Open Source System Admin	3
ITMO 554	Operating Sys Virtualization	3
ITMO 556	Intro to Open Source Software	3
ITMS 548	Cyber Security Technologies	3
ITMS 558	Operating Systems Security	3
ITMT 535	Data Center Architecture	3
ITMT 593	Embedded Systems	3
Select a minimum of three credit hours from Business Development:		3
ITMD 511	Application Dev Methodologies	3
ITMD 532	UML-Based Software Development	3
ITMD 534	Human/Computer Interaction	3
ITMD 535	Human-Computer Interaction Des	3
ITMM 537	Vendor Mgmt/Service Lvl Agrmts	3

ITMM 570	Fund of Mgmt for Tech Prof	3
ITMM 571	Project Management for ITM	3
ITMM 574	ITM Frameworks	3
ITMM 575	Networking/Telecom Management	3
ITMM 581	IT Entrepreneurship	3
ITMM 582	Business Innovation	3
ITMS 578	Cyber Security Mgmt	3
ITMT 531	OO Syst Anlys Mod & Des	3
Research Course		(5-8)
ITMT 591	Independent Study/Research	5-8
Elective Courses		(15-18)
Select 15-18 credit hours from any 500-level ITM, ITMD, ITMM, ITMO, ITMS, ITMT, or TECH courses selected with the student's adviser. ¹		15-18

Minimum degree credits required: 32

¹ Courses from other departments may be selected with adviser approval. Students may select project courses ITMT 594 or ITMT 597 as electives, but a maximum combined total of eight credit hours of ITMT 591, ITMT 594, and ITMT 597 may be applied toward the degree requirements.

Master of Science in Information Technology and Management (Master's Project Option)

Code	Title	Credit Hours
Core Courses		(9)
Select a minimum of three credit hours from Software Development:		3
ITMD 510	Object-Oriented App Develop	3
ITMD 512	Structured/Systems Programming	3
ITMD 513	Open Source Programming	3
ITMD 515	Advanced Software Programming	3
Select a minimum of three credit hours from System Technologies:		3
ITMD 553	Enterprise Intelligent Device	3
ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 565	Rich Internet Applications	3
ITMD 566	Service-Oriented Architectures	3
ITMO 533	Enterprise Server Admin	3
ITMO 540	Intro Data Networks & Internet	3
ITMO 553	Open Source System Admin	3
ITMO 554	Operating Sys Virtualization	3
ITMO 556	Intro to Open Source Software	3
ITMS 548	Cyber Security Technologies	3
ITMS 558	Operating Systems Security	3
ITMT 535	Data Center Architecture	3
ITMT 593	Embedded Systems	3
Select a minimum of three credit hours from Business Development:		3
ITMD 511	Application Dev Methodologies	3
ITMD 532	UML-Based Software Development	3
ITMD 534	Human/Computer Interaction	3
ITMD 535	Human-Computer Interaction Des	3
ITMM 537	Vendor Mgmt/Service Lvl Agrmts	3
ITMM 570	Fund of Mgmt for Tech Prof	3
ITMM 571	Project Management for ITM	3
ITMM 574	ITM Frameworks	3

ITMM 575	Networking/Telecom Management	3
ITMM 581	IT Entrepreneurship	3
ITMM 582	Business Innovation	3
ITMS 578	Cyber Security Mgmt	3
ITMT 531	OO Syst Anlys Mod & Des	3
Research Course		(5-8)
ITMT 594	Special Projects in IT	5-8
or ITMT 597	Special Problem in IT	
Elective Courses		(15-18)
Select 15-18 credit hours from any 500-level ITM, ITMD, ITMM, ITMO, ITMS, ITMT, or TECH courses selected with the student's adviser. ¹		15-18

Minimum degree credits required: 32

¹ Courses from other departments may be selected with adviser approval.

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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

The prerequisite path for this certificate is completion of coursework, training, or certification equivalent to ITM 311 (Beginning Java) and ITMD 510 (Intermediate Java.) Equivalent certification may be Oracle Certified Associate (OCA) Java Programmer + two years industry experience or Oracle Certified Professional (OCP) Java Programmer.

Gainful Employment Disclosure for the Certificate in Advanced Software Development

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMD 515	Advanced Software Programming	3
ITMM 571	Project Management for ITM ¹	3
Select a minimum of two courses from the following:		6
ITMD 511	Application Dev 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/Computer Interaction	3
ITMD 536	Software Testing & Maintenance	3
ITMO 556	Intro 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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

The prerequisite path for this certificate is completion of ITMO 540 *Introduction to Data Networks and the Internet* or equivalent coursework, training, or certification. Equivalent certification may be CompTIA Network+ or Cisco CCNA.

Gainful Employment Disclosure for Certificate in Cyber Security Management

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMS 548	Cyber Security Technologies	3
ITMS 578	Cyber Security Mgmt	3

Select a minimum of two courses from the following:			6
ITMM 586	IT Auditing	3	
ITMS 543	Vulnerability Analys and Ctrl	3	
ITMS 579	Topics in Information Security	1-6	
ITMS 588	Incndnt Rspnse Disaster Rcvry	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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

The prerequisite path for this certificate is completion of ITMO 540 *Introduction to Data Networking and the Internet* and ITMO 556 *Introduction to Open Source Software* (Linux), or equivalent coursework, training, or certification. Equivalent certification may be CompTIA Linux+, LPI Linux Essentials or LPIC-1, or Red Hat Certified System Administrator; and CompTIA Network+ or Cisco CCNA.

Gainful Employment Disclosure for Certificate in Cyber Security Technologies

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMS 543	Vulnerability Analys and Ctrl	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	CST: Projects & Adv 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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

Gainful Employment Disclosure for Certificate in Data Center Operations and Management

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMM 576	Data Center Management	3
ITMO 540	Intro Data Networks & Internet	3
ITMO 554	Operating Sys 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	Incndnt Rspnse Disaster Rcvry	3
Total Credit Hours		12

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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

Gainful Employment Disclosure for Certificate in Digital Voice and Data Communication Technologies

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMO 540	Intro Data Networks & Internet ¹	3
ITMO 545	Telecommunications Technology	3
ITMO 546	Telecomm Over Data Networks	3
Select a minimum of one course from the following:		3
ITMM 575	Networking/Telecom Management	3
ITMO 541	Network Admin & Operations	3
ITMO 547	Projects & 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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

Gainful Employment Disclosure for Certificate in Information Technology Innovation, Leadership, and Entrepreneurship

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMM 571	Project Management for ITM ¹	3
ITMM 581	IT 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	Modeling for Decision-Making	3
INTM 543	Purchasing	3
TECH 581	Consulting for Technical Prof	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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

Gainful Employment Disclosure for Certificate in Systems Administration

Curriculum

Code	Title	Credit Hours
Select one of the following:		6
ITMO 556 & ITMO 553	Intro to Open Source Software and Open Source System Admin	6
ITMO 550 & ITMO 533	Enterprise End-User Sys Admin and Enterprise Server Admin	6
Select a minimum of two courses from the following:		6
ITMM 571	Project Management for ITM	3
ITMO 544	Cloud Computing Technologies	3
ITMO 554	Operating Sys 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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

The prerequisite path for this certificate is completion of coursework, training, or certification equivalent to ITM 311 (Beginning Java), ITMD 510 (Intermediate Java), and ITMD 321 (Introductory Database and SQL). Equivalent certification may be PCEP – Certified Entry-Level Python Programmer, or Oracle Certified Associate (OCA) Java Programmer; and Oracle MySQL Database Administration, or Oracle Database Certified Associate, or Microsoft Certified Solutions Associate (MCSA): SQL Server.

Gainful Employment Disclosure for Certificate in Systems Analysis

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMM 571	Project Management for ITM ¹	3
ITMM 572	Process Engrng for IT Managers	3
ITMT 531	OO Syst Anlys Mod & Des	3
Select a minimum of one course from the following:		3
INTM 522	Modeling for Decision-Making	3
ITMD 511	Application Dev Methodologies	3
ITMD 532	UML-Based Software Development	3
ITMD 534	Human/Computer Interaction	3
ITMD 536	Software Testing & Maintenance	3
TECH 581	Consulting for Technical Prof	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 500-level courses may be later applied toward the Master of Information Technology and Management, Master of Cyber Forensics and Security, or Master of Science in Applied Cybersecurity and Digital Forensics 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.

The prerequisite path for this certificate is ITM 311 or 313 and ITMD 361, or completion of equivalent coursework, training, or certification. Equivalent coursework, training, or certification would include introductory programming and a working knowledge of web development including HTMS, CSS, and Javascript. Equivalent certification may be PCEP – Certified Entry-Level Python Programmer, or Oracle Certified Associate (OCA) Java Programmer; and Microsoft Programming in HTML5 with JavaScript and CSS3 or Udemy HTML, CSS, & JavaScript Certification Course for Beginners.

Gainful Employment Disclosure for Certificate in Web Design and Application Development

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
ITMD 562	Web Site App Development	3
ITMD 565	Rich Internet Applications	3
Select a minimum of two courses from the following:		6
ITMD 534	Human/Computer Interaction	3
ITMD 553	Enterprise Intelligent Device	3

ITMD 554	Mass-Market Intelligent Device	3
ITMD 555	Open-Source Intelligent Device	3
ITMD 563	Intermediate Web App Dev	3
ITMD 564	Adv Web Site App Development	3
ITMD 566	Service-Oriented Architectures	3
ITMD 567	Web Systems Integration	3
ITMD 569	Topics in Application Devlmpnt	3
Total Credit Hours		12

Institute of Design

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Dean

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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 of fields. About fifty percent come from outside the United States. Fifteen full-time and thirty 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 four-semester duration for those holding degrees in industrial or communication design and a five-semester 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 five 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.

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. 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.

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. 381)
- Master of Design Methods (p. 384)
- Doctor of Philosophy in Design (p. 387)

Dual Degree Program

- Master of Design/Master of Business Administration (with Business) (p. 384)
- Master of Design/Master of Public Administration (p. 386)

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: 3 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: 3 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

Stimulus 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 519

Evidence-based Design

Introduction to the use of analytics measure the success of design solutions.

Lecture: 3 Lab: 0 Credits: 1.5

IDN 520

Co-Design + Social Interventions

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: 3

IDN 522

Research Synthesis

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 with min. grade of C

Lecture: 1.5 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.

Credit: Variable

IDN 531

Adaptive Leadership

Explore different established and emerging change management models and their application to design.

Lecture: 3 Lab: 0 Credits: 1.5

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 533**Strategies for Open Innovation**

This course is for students who are interested in leading and facilitating multi-disciplinary collaborative projects using design as know-how to innovate. Students will learn design tactics and strategies for knowledge brokering through tutorials, examples, practical activities and simulations.

Lecture: 1.5 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: 3 Lab: 0 Credits: 1.5,3

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: 3 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: 1.5,3

IDN 540**Innovation 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: 1.5 Lab: 0 Credits: 1.5

IDN 541**Civic Design**

Covers the emerging practice of applying design to areas of civic-oriented challenges.

Lecture: 1.5 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.

Prerequisite(s): IDN 544* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

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: 3 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 558**Innovation Narratives**

In both professional and academic careers, there is an increased need for storytelling skills and self awareness. Creating passion-filled, compelling, and effective stories is a critical part of leadership.

Lecture: 1.5 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.

Prerequisite(s): IDN 544* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

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: 3 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: 3 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**Re-Thinking Systems**

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: 3 Lab: 0 Credits: 3

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: 3 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: 3 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, phenomenology, and structuralism. Comparisons are made between design research and research in other fields.

Lecture: 0 Lab: 3 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**Ph. D. Research and Thesis**

Research and thesis writing for Ph. D. degree.

Credit: Variable

IDN 999**General Elective Placeholder**

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: 3 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 505**Critique Methods**

Explore the various types of critique and their usefulness at different stages of the design process.

Lecture: 3 Lab: 0 Credits: 1.5

IDX 506**Fundamentals of Product Design**

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 509**Data Literacy**

Introduction to the methods, tools, and techniques for working with "quant" data in the design process.

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: 3 Credits: 3

IDX 513**Generative Design**

Explores a variety of digital fabrication tools alongside the language, limitations, and capabilities of contemporary and near-future digital manufacturing.

Lecture: 0 Lab: 3 Credits: 3

IDX 514**Product/Service 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 519**Fundamentals of Web Development**

Prepares students to confidently build projects with front-end web development tools.

Lecture: 0 Lab: 3 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: 3 Credits: 3

IDX 526**Physical + Digital Development**

This course introduces different tools and platforms for the development of interactive systems. Students will employ the different platforms to translate 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: 3 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: 3 Credits: 1.5,3

IDX 529**Applied Tech Frontiers**

Explorations of technology applications and opportunities for contemporary societal issues.

Credit: Variable

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 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 537**Designing Futures**

This course overviews a wide range of methodologies and approaches that have been used to engage in narratives about these futures including backcasting & histories of the future, predictive analytics and big data, forecasting and trend analysis, visioning & "visioneering", scenario planning, anticipatory design, speculative and critical design, science fiction, design fiction, speculative fabulation and feminist futures, Afrofuturism and decolonizing design.

Lecture: 3 Lab: 0 Credits: 3

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: 3 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: 3 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: 3 Credits: 3

IDX 551**Facilitation Methods**

Explores the methods and techniques to guide teams to desired outcomes in ways that build alignment, engagement, and momentum.

Lecture: 0 Lab: 3 Credits: 1.5

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: 3 Credits: 3

IDX 553**Engaging Stakeholders**

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.

Lecture: 1.5 Lab: 0 Credits: 1.5

IDX 554**Agile Culture**

Understanding key principles, values, culture/behaviors, and practices of Agile methodology in design practice.

Lecture: 3 Lab: 0 Credits: 1.5

IDX 560**Introduction to Design Thinking**

An introduction to the techniques and process of problem definition and solution generation as used in the field of design.

Lecture: 3 Lab: 0 Credits: 3

IDX 561**Introduction to Design Concepts**

An introductory course into the methods and techniques of the field of design. Students will learn creative problem solving including how to manage ambiguous problems and work across disciplines.

Lecture: 3 Lab: 0 Credits: 3

IDX 562**Multidisciplinary Prototyping**

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

IDX 598**Independent Study**

Student-driven course to explore contemporary issues in the field of design.

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 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.

Advising

All students must meet with their academic advisers at least once a semester during their program of study. Each meeting should be scheduled prior to course registration for the following semester. All incoming students are assigned an adviser at the time of admission. All students can change their adviser at any time through an eForms petition.

If the required advising meeting is not completed in a particular semester, an academic hold will be placed on the student's record preventing any course registration for the following semester. The hold cannot be removed until the student has completed the advising meeting. Please see the Director of Student Engagement if you have any questions or your assigned adviser is not available.

Curriculum

Requirement	Credits
Minimum Degree Credits	54
Minimum Degree Credits with ESP + Design Course Corequisites	72
Minimum Degree Credits with Foundation Course Prerequisites	69

Core Curriculum

Code	Title	Credit Hours
Required Courses		(15)
IDN 504	Intro to Observing Users	3
or IDN 508	Principles/Methods User Rsrch	
IDN 530	Intro to Design Planning	1.5
IDN 556	Comm 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/Understanding Context	3
Elective Courses		(39)
Select 39 credit hours from any 500-level IDN or IDX non-required course. Up to 12 credit hours may be chosen from IDN 475 - IDN 498, provided that those courses are not also applied as program prerequisites.		39
Total Credit Hours		54

ESP + Design Courses

These courses are corequisite for students who require additional fluency in English and design-specific vocabulary.

Code	Title	Credit Hours
IDN 461	Design Read/Writing Skills I	3
IDN 462	Design Listening and Presentat	3
IDN 463	Cross-Cultural Communication I	2
IDN 464	Cross-Cultural Comm I Lab	1
IDN 466	Design Read/Writing Skills II	3
IDN 467	Listening and Presentation II	3
IDN 468	Cross-Cultural Comm II	2

IDN 469	Cross-Cultural Comm II Lab	1
Total Credit Hours		18

Foundation Courses

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.

Code	Title	Credit Hours
Select a minimum of 15 credit hours from the following:		15
IDN 481	Intro to Design Practice	3
IDN 482	Introduction to Design II	3
IDN 483	Intro to Visual Communication	4
IDN 484	Communication Systems	4
IDN 485	Intro to Objects & Artifacts	4
IDN 486	Intro to Product Design II	4
IDN 487	Introduction to Photography	4
IDN 488	Digital Media	4
Total Credit Hours		15

Elective Courses

Students select a series of courses to meet their professional goals in consultation with their adviser. Courses may be chosen from any 500-level IDN or IDX non-required course, and up to 12 credit hours from the 400-level Foundation courses (IDN 481–IDN 498), provided that those courses are not also applied as program prerequisites. Up to six credit hours may be taken outside of ID with the approval of the student's adviser.

A selection of the available elective courses is below. Note: Some courses are not offered every semester.

Code	Title	Credit Hours
IDN 502	Making the User-Centered Case	1.5
IDN 506	Research Planning & Execution	1.5
IDN 508	Principles/Methods User Rsrch	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	Stimulus in Design Research	1.5
IDN 518	Survey Methods	1.5
IDN 520	Co-Design/Participatory Rsrch	1.5
IDN 522	Coding and Analysis	1.5
IDN 526	Online Research Methods	1.5
IDN 532	Business Frameworks & Strategy	1.5
IDN 534	Business Models and Value Webs	1.5
IDN 536	Intro to Portfolio Planning	1.5
IDN 537	New Venture Design	1.5
IDN 538	Design Planning Workshop	3
IDN 539	Social/Economic Context of Dsg	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	Fund of Visual Communication	1.5

IDN 554	Theories of Communication	1.5
IDN 562	Modeling Complexity	1.5
IDN 564	Info Structuring & 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	1.5
IDN 572	Platform-Based Design Strategy	1.5
IDN 574	Design Process and Knowledge	1.5
IDN 576	Systems Modeling & Prototyping	3
IDN 578	Human System Integration	3
IDX 502	New Product Definition	3
IDX 506	Fundamentals of Product Design	1.5
IDX 510	Design Develop/Implementation	1.5
IDX 512	Product Design Workshop	3
IDX 514	Prod/Ser Architecture/Platfrm	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	Physical + Digital Development	3
IDX 528	Prototyping Interactions	3
IDX 530	Interaction Dsgn Immersive Sys	1.5
IDX 532	Interaction Dsgn Embedded Sys	1.5
IDX 533	Engaging Stakeholders	1.5
IDX 534	Interactive Space	1.5
IDX 536	Extensions of Media/Technology	1.5
IDX 538	Networked Cities	3
IDX 540	Networked Objects	3
IDX 548	Innovation Methods	3
IDX 552	Manage Interdisciplinary Teams	3
IDX 560	Intro to Design Thinking	3
IDX 562	Multidisciplinary Prototyping	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 three credit hours each semester.

Advising

All students must meet with their academic advisers at least once a semester during their program of study. Each meeting should be scheduled prior to course registration for the following semester. All incoming students are assigned an adviser at the time of admission. All students can change their adviser at any time through an eForms petition.

If the required advising meeting is not completed in a particular semester, an academic hold will be placed on the student's record preventing any course registration for the following semester. The hold cannot be removed until the student has completed the advising meeting. Please see the Director of Student Engagement with any questions or if your assigned adviser is not available.

Curriculum

Code	Title	Credit Hours
Required Courses		(9)
IDN 504	Intro to Observing Users	3
IDN 530	Intro 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 description (p. 381).

Master of Design/Master of Business Administration

Curriculum

42 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. 381) description.

Typically, students will reduce the overall credit requirements of typical individual degree programs because M.B.A. will double count six M.Des. credit hours towards general electives and six 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.

Code	Title	Credit Hours
Required Courses		(48)
Institute of Design courses		
IDN 504	Intro to Observing Users	3
or IDN 508	Principles/Methods User Rsrch	
IDN 530	Intro to Design Planning	1.5

IDN 556	Comm 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/Understanding Context	3
Stuart School of Business courses		
BUS 510	Strategy & Innovation	3
BUS 550	Business Statistics	3
BUS 590	Business Strategy Capstone Pro	3
MBA 501	Financial Statement Applicatio	3
MBA 502	International Trade	3
MBA 504	Analytics for Decision Making	3
MBA 505	Microeconomics and Game Theory	3
MBA 506	Leadership and Organization De	3
MBA 509	Financial Management	3
MBA 511	Marketing Strategy	3
MBA 513	Operations & Tech Management	3
Elective Courses		(30)
Select 27 credit hours from any 500-level IDN or IDX non-required course. Up to 12 credit hours may be chosen from IDN 475 - IDN 498, provided that those courses are not also applied as program prerequisites.		27
Select three credit hours from Stuart School of Business		3
Total Credit Hours		78

ESP + Design Courses

These courses are corequisite for students who require additional fluency in English and design-specific vocabulary.

Code	Title	Credit Hours
IDN 461	Advanced Reading and Writing I	3
IDN 462	Advanced Listen, Presentation I	3
IDN 463	Culture and Comm. in Design I	3
IDN 466	Advanced Reading & Writing II	3
IDN 467	Advanced Listen, Present II	3
IDN 468	Culture and Comm. in Design II	3
Total Credit Hours		18

Foundation Courses

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.

Code	Title	Credit Hours
Select a minimum of 15 credit hours from the following:		15
IDN 481	Intro to Design Practice	3
IDN 482	Introduction to Design II	3
IDN 483	Intro to Visual Communication	4
IDN 484	Communication Systems	4
IDN 485	Intro to Objects & Artifacts	4
IDN 486	Embodied Design	4
IDN 487	Introduction to Photography	4
IDN 488	Digital Media	4
Total Credit Hours		15

Elective Courses

Students select a series of courses to meet their professional goals in consultation with their adviser. Courses may be chosen from any 500-level IDN or IDX non-required course, and up to 12 credit hours from the 400-level Foundation courses (IDN 481-IDN 498), provided that

those courses are not also applied as program prerequisites. Students select from the same pool of elective classes as found under the Master of Design (p. 381) description. Up to six credit hours may be taken outside of ID with the approval of the student's adviser.

Master of Design/Master of Public Administration

Curriculum

45 Institute of Design credit hours

24 Stuart School of Business credit hours

The program director or academic advisor 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 description.

Typically, students will reduce the overall credit requirements compared to individual degree programs because M.P.A. will double count 9 M.Des. credit hours towards M.P.A. electives, and M.Des. will double count 9 M.P.A. credit hours towards M.Des. electives. The program director may make exceptions to this plan depending upon the student's individual situation.

Code	Title	Credit Hours
Required Courses		(39)
Institute of Design courses		
IDN 504	Intro to Observing Users	3
or IDN 508	Principles/Methods User Rsrch	
IDN 530	Intro to Design Planning	1.5
IDN 556	Comm 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/Understanding Context	3
Stuart School of Business courses		
PA 501	Introduction to Public Admin	3
PA 502	Organizational Behavior	3
PA 522	Human Resource Management	3
PA 532	Public Financial Management	3
PA 568	Strat Comp in the Public Sect	3
PA 580	Policy Evaluation Analytics	3
PA 581	Policy Design Analytics	3
PA 599	Practicum	3
Elective Courses		(30)
Select 30 credit hours from any 500-level IDN or IDX non-required course. Up to 12 credit hours may be chosen from IDN 475 - IDN 497, provided that those courses are not also applied as program prerequisites.		30
Total Credit Hours		69

ESP + Design Courses

These courses are corequisite for students who require additional fluency in English and design-specific vocabulary.

Code	Title	Credit Hours
IDN 461	Advanced Reading and Writing I	3
IDN 462	Advanced Listen, Presentation I	3
IDN 463	Culture and Comm. in Design I	3
IDN 466	Advanced Reading & Writing II	3
IDN 467	Advanced Listen, Present II	3
IDN 468	Culture and Comm. in Design II	3
Total Credit Hours		18

Foundation Courses

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.

Code	Title	Credit Hours
Select a minimum of 15 credit hours from the following:		15
IDN 481	Intro to Design Practice	3
IDN 482	Introduction to Design II	3
IDN 483	Intro to Visual Communication	4
IDN 484	Communication Systems	4
IDN 485	Intro to Objects & Artifacts	4
IDN 486	Embodied Design	4
IDN 487	Introduction to Photography	4
IDN 488	Digital Media	4
Total Credit Hours		15

Elective Courses

Students select a series of courses to meet their professional goals in consultation with their adviser. Courses may be chosen from any 500-level IDN or IDX non-required course, and up to 12 credit hours from the 400-level Foundation courses (IDN 481-IDN 497), provided that those courses are not also applied as program prerequisites. Students select from the same pool of elective classes as found under the Master of Design (p. 381) description. Up to six credit hours may be taken outside of ID with the approval of the student's adviser.

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 whom 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 in a minimum of 12 credit hours at the Institute of Design. Satisfactory reading knowledge of Chinese, German, French, Italian, Japanese, Korean, Portuguese, Russian, or Spanish 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: 92 credit hours

Coursework: 44 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

44 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. Most coursework credits are earned within the first three terms of enrollment.

Code	Title	Credit Hours
Master's transfer coursework		(32)
Maximum amount eligible for master's degree transfer is 32 credit hours		32
Required Courses		(12)
IDN 685	PhD Principles/Method Dsgn Res	1.5
IDN 687	Philosophl Context Dsgn Rsrch	1.5
IDN 689	Ph.D. Research Seminar (taken twice)	6
PSYC 545	Graduate Statistics I (or equivalent)	3
Ph.D. Research		(48)
IDN 691	Ph. D. Research and Thesis	48
Total Credit Hours		92

Advising

All students must meet with their academic advisers at least once a semester during their program of study. Each meeting should be scheduled prior to course registration for the following semester. All incoming students are assigned an adviser at the time of admission. If the required advising meeting is not completed in a particular semester, an academic hold will be placed on the student's record preventing any course registration for the following semester. The hold cannot be removed until the student has completed the advising meeting. Please see the Ph.D. program director if with any questions or if your assigned adviser is not available.

Lewis College of Science and Letters

Christine L. Himes

Interim Dean

Robert A. Pritzker Science Center, Room 252

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Chicago, IL 60616

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iit.edu/science-letters

The Lewis College of Science and Letters traces its roots to the Lewis Institute, founded in 1895, and to Armour Institute of Technology, founded in 1892. 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, research, data analysis, and communications. The college offers rigorous and relevant programs in the sciences and humanities at the undergraduate and graduate level (including master's, professional master's, and Ph.D.) through seven departments: biology; chemistry; food science and nutrition; humanities; physics; psychology; and social sciences.

Biology (p. 391)

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- Master of Science in Biology for the Health Professions (p. 398)
- Master of Science in Biology with Specialization in Applied Life Sciences (p. 399)
- Master of Science in Biology with Specialization in Biochemistry (p. 400)
- Master of Science in Biology with Specialization in Cell and Molecular Biology (p. 401)
- Master of Science in Biology with Specialization in Computational Genomics (p. 401)
- Master of Science in Biology with Specialization in Microbiology (p. 402)
- Master of Science in Molecular Biochemistry and Biophysics (p. 403)
- Doctor of Philosophy in Biology (p. 404)
- Doctor of Philosophy in Molecular Biochemistry and Biophysics (p. 405)

Chemistry (p. 407)

- Master of Chemistry in Materials Chemistry (p. 415)
- Master of Science in Analytical Chemistry (p. 415)
- Master of Science in Chemistry (p. 416)
- Doctor of Philosophy in Chemistry (p. 418)

CERTIFICATES

- Analytical Method Development (p. 419)
- Analytical Spectroscopy (p. 419)
- Chromatography (p. 419)
- Materials Chemistry (p. 420)
- Regulatory Science (p. 420)

Food Science and Nutrition (p. 422)

DEGREE PROGRAMS

- Master of Food Process Engineering (p. 427)
- Master of Food Safety and Technology (p. 428)
- Master of Science in Food Process Engineering (p. 429)
- Master of Science in Food Safety and Technology (p. 430)
- Doctor of Philosophy in Food Science and Nutrition (p. 431)

CERTIFICATES

- Food Process Engineering (p. 434)
- Food Processing Specialist (p. 434)
- Food Safety and Industrial Management (p. 434)
- Food Safety and Technology (p. 435)

Humanities (p. 436)

DEGREE PROGRAMS

- Master of Science in Technical Communication and Information Architecture (p. 444)
- Master of Science in Technology and Humanities (p. 445)
- Doctor of Philosophy in Technology and Humanities (p. 446)

CERTIFICATES

- Instructional Design (p. 449)
- Technical Communication (p. 449)

Physics (p. 450)

- Master of Health Physics (p. 457)
- Master of Science in Applied Physics (p. 458)
- Master of Science in Physics (p. 459)
- Doctor of Philosophy in Physics (p. 460)

CERTIFICATES

- Radiological Physics (p. 461)

Psychology (p. 462)

DEGREE PROGRAMS

- Master of Science in Industrial-Organizational Psychology (p. 473)
- Master of Science in Psychology (p. 474)
- Master of Science in Rehabilitation and Mental Health Counseling (p. 475)
- Master of Science in Rehabilitation and Mental Health Counseling with Advanced Standing (p. 476)
- Doctor of Philosophy in Psychology with Specialization in Clinical Psychology (p. 477)
- Doctor of Philosophy in Psychology with Specialization in Clinical Psychology: Rehabilitation Track (p. 478)
- Doctor of Philosophy in Psychology with Specialization in Industrial-Organizational Psychology (p. 479)
- Doctor of Philosophy in Rehabilitation Counseling Education (p. 481)

CERTIFICATES

- Psychiatric Rehabilitation (p. 482)
- Rehabilitation Counseling (p. 482)
- Rehabilitation Engineering Technology (p. 482)

Biology

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iit.edu/biology

Interim Chair

Jialing Xiang

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

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

The Graduate Record Examination (GRE) is required, but it can be waived on case by case bases for qualified applicants.

- Master's/Master of Science: 299 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 310 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

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 master's and M.S. comprehensive/Ph.D. qualifying examination.

Degrees Offered

- Master of Science in Biology (p. 397)
- Master of Science in Biology for the Health Professions (p. 398)
- Master of Science in Biology with Specialization in Applied Life Sciences (p. 399)
- Master of Science in Biology with Specialization in Biochemistry (p. 400)
- Master of Science in Biology with Specialization in Cell and Molecular Biology (p. 401)
- Master of Science in Biology with Specialization in Computational Genomics (p. 401)
- Master of Science in Biology with Specialization in Microbiology (p. 402)
- Master of Science in Molecular Biochemistry and Biophysics (p. 403)
- Doctor of Philosophy in Biology (p. 404)
- Doctor of Philosophy in Molecular Biochemistry and Biophysics (p. 405)

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 with min. grade of C or BIOL 515 with min. grade of C

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 510

Medical Microbiology

Properties of pathogenic bacteria, fungi, viruses, and parasites and their mechanisms of pathogenesis with a focus on organisms that cause human disease, including current trends in infectious disease. Credits cannot be granted for both BIOL 510 and BIOL 410.

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 with min. grade of C

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.

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 521

Population Genetics

The study of genetic variation in natural populations is the foundation for modern evolutionary biology. Population genetics covers both the theoretical study of the effects of various forces on genetic diversity and the empirical analysis of genetic variation observed in real populations. Throughout the course, students' understanding of population genetics theory will be reinforced with examples of applications. Topics will include genetic drift, genealogical approaches and coalescence, structured populations and migration mutation and natural selection.

Lecture: 3 Lab: 0 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: 6 Credits: 3

BIOL 542**Advanced Microbiology**

Advanced Microbiology (Biol 542) is a lecture course designed to review concepts of contemporary microbiology and the diversity of the microbial world with an emphasis on the biochemical and molecular strategies used to survive in different environments. The course will cover diverse microbiological topics such as metabolism, growth, production of foods, agriculture, biotechnology, fuel production, bioremediation, environment, etc.

Prerequisite(s): BIOL 544 and BIOL 504

Lecture: 3 Lab: 0 Credits: 3

BIOL 543**Advanced Microbiology and Immunology Laboratory**

This course provides hands-on experience on the main techniques used in microbiology and immunology. The course allows graduate and undergraduate students to acquire the necessary experience to continue their careers in academy or in industry. Focus on implementing aseptic technique, identification of microorganisms by several methods and Biotechnology procedures such as bacterial genome editing and yeast fermentation. Antibody properties will be explored and exploited, including antigen-antibody reaction, immunodetection of microorganisms, co-immunoprecipitation of proteins and ELISA. Properties of immune cells will be studied, such as phagocytosis and macrophage migration.

Prerequisite(s): BIOL 225 or BIOL 533 with min. grade of C

Lecture: 0 Lab: 6 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 with min. grade of C and BIOL 446 with min. grade of C) or (BIOL 533 with min. grade of C and BIOL 544 with min. grade of C)

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 551**Microbial Genomics**

Microbes and associated microbiomes are highly relevant to human health and environmental issues. Advances in DNA sequencing technologies enabled investigations of microbes and microbiomes at an unprecedented depth. In this lab course, students will use a combination of wet lab approaches including high-throughput sequencing technologies and dry lab computational techniques to investigate various microbial genomes, metagenomes and biomes.

Prerequisite(s): BIOL 501 with min. grade of C and BIOL 550 with min. grade of B and BIOL 515 with min. grade of C

Lecture: 0 Lab: 6 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 561**Radiation Biophysics**

Energy loss by ionizing radiation. Target theory. Direct and indirect action. Radiation inactivation of proteins, nucleic acids, microorganisms, and humans. Role of DNA repair in mitigating damage. Stochastic and non-stochastic damage. Radiation effects in vivo. Radiation therapy. Effects of non-ionizing radiation. Same as PHYS 561.

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.

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: 3 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: 3 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: 3 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: 3 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: 1 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: 1 Credits: 1

BIOL 597**Special Problems**

Special problems in biology. Instructor permission required.

Credit: Variable

BIOL 600**Continuation of Residence**

Lecture: 0 Lab: 1 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

SCI 595**Ethics for the Health Professions**

Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.

Lecture: 1 Lab: 0 Credits: 1

Master of Science in Biology

All the students in the program have to complete:

- 1) Comprehensive examination
- 2) Option 1: Thesis or 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 degree in the future. This option is available on a competitive basis. Students choosing the thesis option must complete six credit hours of thesis research (BIOL 591). This option requires the students to write a thesis based on their laboratory research.

Non-Thesis Option

The non-thesis option is intended 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

Code	Title	Credit Hours
Required Courses		(16)
BIOL 501	Graduate Laboratory Techniques	2
BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 533	Adv Graduate Lab 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	Resrch Tech in Biol Sciences I and Resrch Techniqs in Biol Sci 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 nine credit hours of electives may be 400-level coursework. No more than nine credit hours may be non-biology courses.

Code	Title	Credit Hours
Required Courses		(22)
BIOL 504	Biochemistry	3
BIOL 510	Medical Microbiology	3
BIOL 515	Molecular Biology	3
BIOL 526	Developmental Biology	3
BIOL 527	Immunology and Immunochemistry	3
BIOL 530	Human Physiology	3
BIOL 544	Molecular Biology of Cells	3
BIOL 595	Biology Colloquium	1
or SCI 595	Ethics for Health Professions	
Elective Courses		(10)
Select 10 credit hours from the following courses:		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	Chemometrics & Statistics	3
COM 421	Technical Communication	3
COM 428	Verbal Visual Communications	3
COM 435	Intercultural Communication	3
COM 523	Communicating Science	3
COM 577	Communication Law and Ethics	3
FDSN 501	Nutrition, Metabolism & Health	3
PSYC 411	Medcl Aspects of Dsblng Cond	3
PSYC 502	Social Bases of Behavior	3
SCI 522	Public Engagement 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

It is an exciting time to be in the life sciences, with opportunity for students to be on the front lines of new drug discovery and technological innovation. The global life sciences industry is expanding to meet the needs of a growing and self-advocating, aging population. The discovery for and application of treatments and cures for serious illnesses such as heart disease, Alzheimer's, and diabetes is intensifying at a rapid rate. Simultaneously, there is a drive to improve our quality of life and life span.

The Master of Science in Biology with Specialization in Applied Life Sciences program is highly flexible but at its core provides education and preparation for professional biological careers and/or further education. The degree can be obtained without a thesis, entirely online, and full- or part-time.

Admission Requirements

Preferred candidates will have a minimum cumulative undergraduate GPA of 3.0/4.0, though exceptions may be made with validated work experience. Graduate Record Examination (GRE) scores must be submitted with the following minimum scores: 305 (quantitative + verbal), and 2.5 (analytical writing). The GRE requirement is waived for applicants who hold a bachelor's degree with a cumulative undergraduate GPA of 3.0/4.0 or higher from a U.S. accredited institution of higher learning.

Any applicant whose undergraduate degree was earned at an institution where the primary language of instruction is not English must submit Test of English as a Foreign Language (TOEFL), Pearson Test of English (PTE), or International English Language Testing System (IELTS) scores, which must satisfy Illinois Institute of Technology's English language proficiency test requirements (see the Graduate Admission section for more information).

Curriculum

Code	Title	Credit Hours
Required Courses		(20)
BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3
BIOL 524	Sci & Law: Intro IP Law/Patent	2
BIOL 544	Molecular Biology of Cells	3
BIOL 581	Capstone ¹	3
CHEM 519	Good Manufacturing Practices	3
MATH 525	Statistical Models and Methods	3
Elective Courses		(12)
Select a minimum of 12 credit hours from the following:		12
BIOL 503	Virology	3
BIOL 512	Advanced Biochemistry	3
BIOL 514	Toxicology	3
BIOL 526	Developmental Biology	3
BIOL 527	Immunology and Immunochemistry	3
BIOL 542	Advanced Microbiology	3
BIOL 550	Bioinformatics	3
BIOL 555	Macromolecular Structure	3
BIOL 562	Curr Topics in Functl Genomics	3
CHEM 518	Understanding ICH Guidelines	3
SCI 511	Project Management	3
SCI 522	Public Engagement Scientists	3
Total Credit Hours		32

¹ BIOL 581 Capstone may be replaced with a suitable IPRO course at the program director's discretion.

Note: Up to nine credit hours of 400-level coursework, including six credit hours of IPRO courses, may fulfill degree 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 rigorous curriculum of our MS in Biochemistry specialization program allows the students to gain a firm foundation in the field of biochemistry, both in biological theory and experimentation, and to pursue a choice of many career paths after graduation.

Curriculum

Code	Title	Credit Hours
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	Adv Graduate Lab 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	Resrch Tech in Biol Sciences I and Resrch Techniqs in Biol Sci II	6
Option 3		
BIOL 591	Research and Thesis M.S.	6
Elective Courses		(5-6)
Select five to six 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

32-34 credit hours

The Cell and Molecular Biology MS specialization is designed to provide students with solid foundation in the area of cell and molecular biology. Our rigorous curriculum combined with research opportunities offered by the department provide the students with the knowledge, skills, and experiences to pursue careers in the field of Cell and Molecular Biology.

Curriculum

Code	Title	Credit Hours
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	Adv Graduate Lab 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	Resrch Tech in Biol Sciences I and Resrch Techniqs in Biol Sci II	6
Option 3		
BIOL 591	Research and Thesis M.S.	6
Elective Courses		(5-6)
Select five to six 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 Computational Genomics

Code	Title	Credit Hours
Required Courses		(15)
BIOL 501	Graduate Laboratory Techniques	2
BIOL 504	Biochemistry	3
BIOL 515	Molecular Biology	3

BIOL 533	Adv Graduate Lab Techniques	3
BIOL 544	Molecular Biology of Cells	3
BIOL 595	Biology Colloquium	1
Specialization Courses		(9)
BIOL 521	Population Genetics	3
BIOL 550	Bioinformatics	3
BIOL 551	Microbial Genomics	3
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	Resrch Tech in Biol Sciences I and Resrch Techniqs in Biol Sci II	6
Option 3		
BIOL 591	Research and Thesis M.S.	6
Elective Courses		(3)
Select three credit hours from the following:		3
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		33

¹ Student may be approved for special problems as appropriate.

Master of Science in Biology with Specialization in Microbiology

32-34 credit hours

The MS with Microbiology specialization is designed to provide students with solid foundation in the area of microbiology. Our rigorous curriculum combined with the research opportunities offered by the department provides the students with the knowledge, skills, and experiences to pursue careers in the field of Microbiology.

Curriculum

Code	Title	Credit Hours
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	Adv Graduate Lab 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	Resrch Tech in Biol Sciences I and Resrch Techniqs in Biol Sci II	6
Option 3		
BIOL 591	Research and Thesis M.S.	6
Elective Courses		(5-7)
Select five to seven 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

The Molecular Biochemistry and Biophysics (MBB) program complements more traditional M.S. programs in biology, chemistry and physics, by offering an integrated, molecular-based approach to understanding biological problems, taking insights from all three disciplines.

The MBB M.S. program at Illinois Tech features a diverse array of graduate courses. Courses offered include Advanced Biochemistry, Macromolecular Structure; Molecular Biology; Molecular Biophysics; Physical Biochemistry; and more. Illinois Tech's MBB M.S. program provides the skills, knowledge, and experiences to open doors to interdisciplinary career opportunities.

All the students in the program have to complete:

- 1) Comprehensive examination
- 2) Option 1: Thesis or 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; one credit hour of BIOL 595; five to six credit hours of approved electives; and six credit hours of research toward the thesis (BIOL 591), or BIOL 581 and one additional elective, or BIOL 522 and BIOL 523.

Code	Title	Credit Hours
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	Adv Graduate Lab 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	Resrch Tech in Biol Sciences I and Resrch Techniqs in Biol Sci II	6
Option 3		
BIOL 591	Research and Thesis M.S.	6
Elective Courses		(5-6)
Select five to six 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 six 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 581 or a laboratory-based research project in BIOL 522 plus BIOL 523.

Doctor of Philosophy in Biology

The Biology department offers graduate programs leading to Ph.D. degrees in biology, concentrating educational and research activities in the areas of biochemistry, bioinformatics, cell and molecular biology, and microbiology. Our Ph.D. program is highly flexible and is tailored to fit the individual students background and goals.

A career with a Ph.D. in biology will depend on the thesis's focus. Positions are available in academia, healthcare, industry, and government facilities.

Curriculum

A minimum of 72 credit hours is required for the Ph.D. degree in biology. Students should consult the Transfer Credit section (p. 560) 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. 391)).

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 by the department. 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:

Code	Title	Credit Hours
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	Curr Topics in Functl Genomics	3
BIOL 597	Special Problems	1-3
PHYS 410	Molecular Biophysics	3
Ph.D. Research		(24-36)
BIOL 691	Research and Thesis Ph.D.	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

The Ph.D. program in Molecular Biochemistry and Biophysics (MBB) focuses on interdisciplinary research and coursework and is flexible to fit your background and goals. MBB complements more traditional graduate programs in biology, chemistry and physics by offering an integrated, molecular-based approach.

The department has state-of-the-art computer and laboratory equipment in which to conduct research, including facilities for X-ray scattering and imaging at the Advanced Photon Source at Argonne National Laboratory.

Curriculum

A minimum of 72 credit hours of instruction is required for the MBB Ph.D. program. Students should consult the Transfer Credit section (p. 560) 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 by the department. 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:

Code	Title	Credit Hours
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 (four 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 Ph.D.	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. 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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Chair

Yuanbing Mao

Associate Chair

Katie Leight

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. 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, UV-vis spectrometers, Fourier transform infrared spectrometers, Raman spectrometer, differential scanning calorimeter, thermogravimetric analyzer, atomic force microscope, fluorescence microscope, mass spectrometers, facilities for high-pressure liquid chromatography and gas chromatography, and high-performance computer clusters, among others. 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 Ph.D. program are expected to join a research group and to establish a four-member supervisory committee (SC) by the end of the second semester. They are required to take and pass the Ph.D. qualifying examination by the end of their fourth semester. The examination is a two-step process that consists of a mini-proposal based on an original research topic that the student submits to the SC by the end of the third semester. Upon approval, the student prepares for a full proposal followed by an oral defense before the SC. Students are allowed two attempts at the qualifying examination but must pass it by the end of the fourth semester. Students passing this examination at the Ph.D. level are judged to be qualified to continue in the Ph.D. program. Students who fail the PhD qualifying examination can choose to graduate with a M.S. degree.

All students in the Ph.D. program who have passed the qualifying examination must take and pass a comprehensive examination at least a year prior to their thesis defense. To pass the Ph.D. comprehensive examination, students will write a research progress report and defend it before the SC. 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 required coursework, a written dissertation, and a final oral thesis defense approved by the academic adviser and the SC.

M.S. with thesis students fulfill their comprehensive exam requirement with their thesis defense. M.S. non-thesis students may fulfill their comprehensive exam requirement with an oral examination following their adviser's instructions. M.S. students may also choose to take the Ph.D. qualifying examination. Students passing this examination may pursue readmission into the Ph.D. program.

Admission Requirements

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

The Graduate Record Examination (GRE) is not required, but is recommended for PhD applicants.

Minimum TOEFL Scores

80/213/550 (internet-based/computer-based/paper-based test scores)

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 M.S. comprehensive/Ph.D. qualifying examination.

Degrees Offered

- Master of Chemistry in Materials Chemistry (p. 415)
- Master of Science in Analytical Chemistry (p. 415)
- Master of Science in Chemistry (p. 416)
- Doctor of Philosophy in Chemistry (p. 418)

Certificate Programs

- Analytical Method Development (p. 419)
- Analytical Spectroscopy (p. 419)
- Chromatography (p. 419)
- Materials Chemistry (p. 420)
- Regulatory Science (p. 420)

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 spectrometry, molecular luminescence, infrared spectrometry, mass spectrometry, radio chemistry, raman spectrometry, nuclear magnetic resonance spectrometry, 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

Chemometrics and Statistics in Chemistry

This course is carefully designed to provide a vigorous training on statistical methods to graduate students and industry professionals for analysis of real life projects so they can function effectively as part of an innovative and scientific community. The topics include, but not limited to, advanced error analysis, statistical inference, hypothesis testing, probability density functions, sampling estimation, applied regression and multivariable methods, non-parametric analysis, outlier identification methods, and optimization and experimental design. In this course, an advanced statistical software program is introduced with example problems for comprehensive analysis of data and interpretation of the results. The course also discusses various topics for scientific interpretation of data set for chemical, environmental, and biological engineering disciplines.

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 with min. grade of C

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 with min. grade of C

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 stereochemical 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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C and CHEM 344 with min. grade of C

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 with min. grade of C

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 adsorbed 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 with min. grade of C

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 553 with min. grade of C and CHEM 550 with min. grade of C

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 with min. grade of C and CHEM 344 with min. grade of C

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 561**Laboratory Rotations**

This course requires each student to complete research rotations in three different laboratories, 4 weeks in each lab. It allows students to explore various areas of chemical research before committing to a single lab to conduct thesis research. The course intends to give students an opportunity to learn what research topics excite them, what techniques they favor and what lab environment is a good fit. At the same time, rotations provide faculty the mechanism for evaluating students as candidates to join their lab. Submission of a report is required upon the completion of each rotation.

Lecture: 0 **Lab:** 9 **Credits:** 3

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:** 1 **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:** 1 **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 with min. grade of C

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 with min. grade of C

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 with min. grade of C and CHEM 455 with min. grade of C

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 with min. grade of C

Lecture: 0 Lab: 1 Credits: 1

CHEM 691**Research and Thesis Ph.D.**

(Credit: Variable) Instructor permission required.

Credit: Variable

CHEM 700**Practical Laboratory for Analytical Chemistry**

In this one-week intensive course, students will gain hands-on experience using analytical instruments. A brief review of theory of instrumentation will be covered. Students will carry out practical problems and will present their findings.

Lecture: 2 Lab: 4 Credits: 2

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

SCI 595

Ethics for the Health Professions

Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.

Lecture: 1 Lab: 0 Credits: 1

Master of Chemistry in Materials Chemistry

The professional master's program in materials chemistry is a part-time, online program designed for students 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, project management, communication, and intellectual property management. It provides 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 skills.

Admission

Applicants are evaluated on an individual basis but are expected to hold a bachelor's degree 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.

Applicants are required to submit transcripts, one letter of recommendation, an application fee, and a professional statement. GRE scores are required for international students, domestic students with an undergraduate GPA between 2.5 and 3.0, or at the request of the admissions committee. The minimum GRE score for admissions consideration is 300 (quantitative + verbal) and 2.5 (analytical writing).

A final comprehensive examination is required for graduation. This program is also available on the web. Students should consult iit.edu/chemistry for more information.

Curriculum

Code	Title	Credit Hours
Required Courses		(18)
CHEM 505	Spectroscopic Methods I	3
CHEM 509	Physcl Meths of Charztn	3
CHEM 521	Structural Inorg/Material Chem	3
CHEM 522	Efficient Cheml&Mtrls Synths	3
CHEM 535	Polymer Synthesis	3
SCI 511	Project Management	3
Elective Courses		(14)
Select a minimum of fourteen credit hours from the following:		14
CHEM 470	Introduction to Polymers	3
CHEM 513	Chemometrics & Statistics	3
CHEM 519	Good Manufacturing Practices	3
CHEM 520	Advanced Inorganic Chemistry	3
CHEM 524	Synths & Intellect Prop Mgmt	2
CHEM 530	Organic Reaction Mechanisms	3
CHEM 531	Tactics in Organic Synthesis	3
CHEM 542	Polymer Charact & Analysis	3
CHEM 544	Colloids&Colloid Analysis	2
SCI 522	Public Engagement Scientists	3
Total Credit Hours		32

Master of Science in Analytical Chemistry

Curriculum

Code	Title	Credit Hours
Required Courses		(21)
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	Physcl Meths of Charztn	3
CHEM 512	Spectroscopic Methods II	2
CHEM 515	Gas Chromatography	3

CHEM 516	Liquid Chromatography	3
Elective Courses		(11)
Select a minimum of 11 credit hours from the following:		11
CHEM 542	Polymer Charact & Analysis	3
CHEM 543	Analytical Chem in Pharm Labs	2
CHEM 544	Colloids&Colloid Analysis	2
CHEM 700	Practical Lab Analytical Chem	2
INTM 511	Industrial Leadership	3
MATH 525	Statistical Models and Methods	3
SCI 511	Project Management	3
SCI 522	Public Engagement Scientists	3
Total Credit Hours		32

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.

The M.S. Chemistry program is tailored to fit the student's background and goals. Two options are available: a thesis option, and a non-thesis option.

Thesis Option

Students seeking the M.S. in Chemistry degree with the thesis option must also register for six to eight credit hours 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. M.S. Chemistry students fulfill their comprehensive examination requirement with their thesis defense.

Non-Thesis Option

Students seeking the M.S. Chemistry non-thesis degree must pass an oral comprehensive examination by the end of the fourth semester in the program. The non-thesis program is intended for students to develop skills necessary in preparation for careers in the highly competitive chemical industry, education, and administration, among others. It is also tailored for students in the IIT-Paris double degree program. The IIT-Paris program can be completed in one calendar year by taking classes in the fall, spring, and summer semesters.

Curriculum

Master of Science in Chemistry (Coursework Only Option)

Code	Title	Credit Hours
Chemistry Core Courses		(21)
CHEM 584	Graduate Seminar in Chemistry	1
CHEM 585	Chemistry Colloquium	1
CHEM 585	Chemistry Colloquium	1
Select a minimum of six credit hours from the following: ¹		6
CHEM 461	Bioanalytical Chemistry Lab	3
CHEM 463	Analytical Method Develop Lab	3
CHEM 472	Environmental Chemistry	3
CHEM 476	Forensic Chemistry Laboratory	3
CHEM 526	Graduate Chemistry Laboratory	3
CHEM 534	Advanced Spectroscopic Methods	4
CHEM 560	Advanced Chemistry Projects	1-4
CHEM 597	Reading and Special Problems	1-6
Select a minimum of 12 credit hours 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

Professional Development Courses (5-6)

 Select a minimum of two courses from the following: ² 5-6

CHEM 513	Chemometrics & Statistics	3
CHEM 524	Synths & Intellect Prop Mgmt	2
INTM 511	Industrial Leadership	3
SCI 511	Project Management	3
SCI 522	Public Engagement Scientists	3

Elective Courses (5-6)

 Select a minimum of five to six credit hours of 400-level and above CHEM courses in consultation with adviser ³ 5-6

Minimum degree credits required: 32
¹ For students in the IIT-Paris partner program, a two-credit hour CHEM 560 must be taken in the summer.

² For students in the IIT-Paris partner program, two professional development courses can be substituted by 400- or 500-level chemistry electives.

³ For students in the IIT-Paris partner program, six credit hours of transferred engineering courses can be substituted for the elective courses.

Master of Science in Chemistry (Thesis Option)

Code	Title	Credit Hours
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
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
Elective Courses		(9-11)
Select 9-11 credit hours of 400-level and above CHEM courses in consultation with adviser		9-11
Thesis Research		(6-8)
CHEM 591	Research and Thesis M.S.	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

Code	Title	Credit Hours
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

Code	Title	Credit Hours
Required Courses		(9-11)
CHEM 508	Analytical Methods Development	2
CHEM 516	Liquid Chromatography	3
Select a minimum of four to six credit hours from the following courses:		4-6
CHEM 500	Advanced Analytical Chemistry	3
CHEM 505	Spectroscopic Methods I	3
CHEM 509	Physicl Meths of Charztn	3
CHEM 512	Spectroscopic Methods II	2
CHEM 515	Gas Chromatography	3
CHEM 542	Polymer Charact & Analysis	3
CHEM 543	Analytical Chem in Pharm Labs	2
CHEM 544	Colloids&Colloid Analysis	2
CHEM 700	Practical Lab Analytical Chem	2
MATH 525	Statistical Models and Methods	3
Total Credit Hours		9-11

Gainful Employment Disclosure for the Certificate in Analytical Method Development

Certificate in Analytical Spectroscopy

Curriculum

Code	Title	Credit Hours
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 508	Analytical Methods Development	2
CHEM 509	Physicl Meths of Charztn	3
CHEM 515	Gas Chromatography	3
CHEM 516	Liquid Chromatography	3
CHEM 542	Polymer Charact & Analysis	3
CHEM 543	Analytical Chem in Pharm Labs	2
CHEM 544	Colloids&Colloid Analysis	2
CHEM 700	Practical Lab Analytical Chem	2
MATH 525	Statistical Models and Methods	3
Total Credit Hours		9-11

Gainful Employment Disclosure for the Certificate in Analytical Spectroscopy

Certificate in Chromatography

Curriculum

Code	Title	Credit Hours
Required courses		(10-12)
CHEM 515	Gas Chromatography	3
CHEM 516	Liquid Chromatography	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 508	Analytical Methods Development	2
CHEM 509	Physicl Meths of Charztn	3
CHEM 512	Spectroscopic Methods II	2
CHEM 542	Polymer Charact & Analysis	3
CHEM 543	Analytical Chem in Pharm Labs	2
CHEM 544	Colloids&Colloid Analysis	2
CHEM 700	Practical Lab Analytical Chem	2
MATH 525	Statistical Models and Methods	3
Total Credit Hours		10-12

Gainful Employment Disclosure for Certificate in Chromatography

Certificate in Materials Chemistry Curriculum

Code	Title	Credit Hours
Required Courses		(6)
Select a minimum of one course from the following:		3
CHEM 505	Spectroscopic Methods I	3
CHEM 509	Physicl Meths of Charztn	3
CHEM 512	Spectroscopic Methods II	2
CHEM 542	Polymer Charact & Analysis	3
Select a minimum of one course from the following:		3
CHEM 521	Structural Inorg/Material Chem	3
CHEM 522	Efficient Cheml&Mtrls Synths	3
CHEM 530	Organic Reaction Mechanisms	3
CHEM 531	Tactics in Organic Synthesis	3
CHEM 535	Polymer Synthesis	3
Elective Courses		(6)
Select an additional six credit hours from the courses above.		6
Total Credit Hours		12

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.

Gainful Employment Disclosure for the Certificate in Materials Chemistry

Certificate in Regulatory Science Curriculum

Code	Title	Credit Hours
Required courses		(10-12)
CHEM 518	Understanding ICH Guidelines	3
CHEM 519	Good Manufacturing Practices	3
Select four to six credit hours from the designated regulatory science electives		4-6
Total Credit Hours		10-12

Regulatory Science Electives

Code	Title	Credit Hours
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	Curr Topics in Functl Genomics	3
CHEM 500	Advanced Analytical Chemistry	3
CHEM 505	Spectroscopic Methods I	3
CHEM 508	Analytical Methods Development	2
CHEM 700	Practical Lab Analytical Chem	2
CHEM 509	Physcl Meths of Charztn	3
CHEM 512	Spectroscopic Methods II	2
CHEM 515	Gas Chromatography	3
CHEM 516	Liquid Chromatography	3
CHEM 524	Synths & Intellect Prop Mgmt	2
CHEM 542	Polymer Charact & Analysis	3
CHEM 543	Analytical Chem in Pharm Labs	2
CHEM 544	Colloids&Colloid Analysis	2

Gainful Employment Disclosure for Certificate in Regulatory Science

Food Science and Nutrition

Food Science and Nutrition

IIT Tower

Room 18C5-2

Chicago, IL 60601

708-563-8190

iit.edu/fdsn

Chair

Britt Burton-Freeman

Manager, Academic Programs and Initiatives

Todd Diel

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) consists of Illinois Institute of Technology faculty, in collaboration with U.S. Food and Drug Administration (FDA) scientists, and food industry experts, and 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

FdSN makes use of the facilities of Illinois Tech's Moffett campus - home of the university's Institute for Food Safety and Health (IFSH.) These 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

All programs in the Department of Food Science and Nutrition require a bachelor's degree in chemistry; biology; food science; nutrition; chemical, agricultural, food, or environmental engineering; or a related field.

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

- Master of Science in Food Safety and Technology or Food Process Engineering: 304 (quantitative + verbal)
- Master of Food Safety and Technology or Food Processing Engineering: 295 (quantitative + verbal)

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.

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

Note: Certificate programs do not require GRE and TOEFL scores.

Degrees Offered

- Master of Food Process Engineering (p. 427)
- Master of Food Safety and Technology (p. 428)
- Master of Food Safety and Technology with Specialization in Business (p. 428)
- Master of Food Safety and Technology with Specialization in Industrial Management (p. 428)
- Master of Science in Food Process Engineering (p. 429)
- Master of Science in Food Safety and Technology (p. 430)
- Doctor of Philosophy in Food Science and Nutrition (p. 431)

Certificate Programs

- Food Process Engineering (p. 434)
- Food Processing Specialist (p. 434)
- Food Safety and Industrial Management (p. 434)
- Food Safety and Technology (p. 435)

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.

Corequisite(s): FDSN 510

Lecture: 3 Lab: 0 Credits: 3

FDSN 510

Fundamentals of Biostatistics and Epidemiology Laboratory in Food Science and Nutrition

This laboratory course covers fundamental concepts in biostatistics and epidemiology with an emphasis on applications to 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. Self-directed course.

Corequisite(s): FDSN 509

Lecture: 0 Lab: 2 Credits: 1

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 519

Food Process Engineering Lab

This course provides hands on experience to students on various unit operations. Students will be exposed to heat and mass transfer in food processing, fluid flow, preservation processes, cooling, freezing, freeze drying, thermometry and alternative methods of food processing.

Lecture: 0 Lab: 3 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, mesophilic 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 with min. grade of C

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 535**Performance Management in Food Operations**

Creating an organization-wide culture of quality and performance is critical to managing the unique demands of a food processing company. Learn how to develop, manage, and improve food production processes, implement lean principles to eliminate waste and improve yields, and measure operational performance. Topics covered include budgeting and financial tools, introducing new food products and processes, Total Quality Management (TQM), evaluation and management of supply chain activities, and strategy deployment techniques. This course includes a Project Team Assignment from the participating plant personnel with at least one - two visits to a Food Processing Plant in the Chicago Area. An introductory course in Food Processing or Food Safety is helpful. Experience in MS Excel Worksheets, MS Word, and MS Power Point is highly recommended. This course ideally follows the FSN 408 508 Food Product Development Course as it teaches the final phases of food product development of taking a product into a manufacturing operation and how to ensure optimum performance in production.

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: 1 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: 1 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

FDSN 691**Research and Thesis**

Research and Thesis for Ph.D. Food Science Candidates.

Credit: Variable

FDSN 695**Food Science and Nutrition Research Seminar**

This course is designed for Ph.D. students to attend research seminars that are presented by invited speakers from academia, food industry and federal government agencies to broaden their understandings and knowledge of various scientific topics and original research in Food Science and Nutrition. This course is mandatory for all Ph.D. students enrolled in the FDSN program. A minimum of 2 credits or 2 semesters of attendance is required for each student. It does not deal with specific techniques per se, but rather with the assumptions and the logic underlying food science and nutrition research. Students will become acquainted with a variety of approaches to research design from the speakers which, in turn, will help to develop their own research projects. A written report that summarizes the major impacts and findings of all presentations is due at the end of the semester.

Lecture: 1 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, six to eight credit hours must be selected from FdSN elective courses, and six to eight 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.

Code	Title	Credit Hours
Core Courses		(18)
FDSN 505	Food Microbiology	3
FDSN 506	Food Microbiology Laboratory ¹	3
FDSN 521	Food Process Engineering	3
FDSN 522	Adv Food Process Engineering	3
FDSN 524	Fundamentals of Food Science	3
FDSN 541	Principles of Food Packaging	3
Electives		(12-16)
Select six to eight credit hours from the following:		6-8
FDSN 501	Nutrition, Metabolism & Health	3
FDSN 502	Develop, Deliver, Disseminate	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 Regs	3
FDSN 523	Food Engineering Proc Delivery	3
FDSN 526	Engineering Principles of Food	3
FDSN 531	HACCP Planning/Implementation	3
FDSN 593	Seminar on Food Safety & Tech	1
FDSN 594	Special Projects ²	1-6
FDSN 597	Special Problems ²	1-6
Select six to eight credit hours from the following:		6-8
CHE 426	Statistical Tools Engineers	3
CHE 439	Numerical Data Analysis	3
CHE 494	Process Design I	3
CHE 560	Ststcl Qlty Process Control	3
CHE 577	Bioprocess Engineering	3
ENVE 513	Biotech Processes in ENVE	3
ENVE 542	Physcheml Prcs in Envir Eng	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 six 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 eight 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 credit hours must be selected from electives. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Code	Title	Credit Hours
Core Course		(18)
FDSN 505	Food Microbiology	3
FDSN 506	Food Microbiology Laboratory ¹	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)
Select 14 credit hours from the following:		14
FDSN 501	Nutrition, Metabolism & Health	3
FDSN 502	Develop, Deliver, Disseminate	3
FDSN 504	Food Biotechnology	3
FDSN 508	Food Product Development	3
FDSN 509	Biostatistics & Epidemiology	3
FDSN 510	Fund Biostats/Epidemiology Lab	1
FDSN 511	Food Law and Regulations	3
FDSN 519	Food Process Engineering Lab	3
FDSN 522	Adv Food Process Engineering	3
FDSN 531	HACCP Planning/Implementation	3
FDSN 593	Seminar on Food Safety & Tech	1
FDSN 594	Special Projects	1-6
FDSN 597	Special Problems	1-6
Total Credit Hours		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 six 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 eight 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.

Note: Stuart School of Business tuition and fees apply to these courses. Applicants to the program are not required to take the GMAT.

Code	Title	Credit Hours
Specialization Core Course Requirement		(3)
BUS 510	Strategy & Innovation	3
Specialization Electives		(6)
Select a minimum of two courses from the following:		6

MBA 501	Financial Statement Applicatio	3
MBA 509	Financial Management	3
MBA 511	Marketing Strategy	3
MBA 513	Operations & Tech 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.

Code	Title	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	Appl Strat for Competitive Ent	3
INTM 535	Perf Mgmt in Food Operations	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, six to eight credit hours in research and thesis, six credit hours must be taken from Department of Chemical and Biological Engineering courses, and the remaining one to two credit hours can be taken from FdSN electives, if needed.

Code	Title	Credit Hours
Core Courses		(18)
FDSN 505	Food Microbiology	3
FDSN 506	Food Microbiology Laboratory	3
FDSN 521	Food Process Engineering	3
FDSN 522	Adv 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 Engineers	3
CHE 439	Numerical Data Analysis	3
CHE 494	Process Design I	3
CHE 560	Ststcl Qlty Process Control	3
CHE 577	Bioprocess Engineering	3
ENVE 513	Biotech Processes in ENVE	3
ENVE 542	Physcheml Prcs in Envir Eng	3
FdSN Electives		(0-2)
Select zero to two credit hours from the following:		0-2

FDSN 501	Nutrition, Metabolism & Health	3
FDSN 502	Develop, Deliver, Disseminate	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 Regs ¹	3
FDSN 523	Food Engineering Proc Delivery ¹	3
FDSN 526	Engineering Principles of Food ¹	3
FDSN 531	HACCP Planning/Implementation	3
FDSN 593	Seminar on Food Safety & Tech	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, six to eight credit hours must be in research and thesis work and six to eight credit hours from electives. Courses are offered at the Mies Campus or via internet with the exception of FDSN 506.

Code	Title	Credit Hours
Core Course		(17)
FDSN 505	Food Microbiology	3
FDSN 506	Food Microbiology Laboratory	3
FDSN 507	Food Analysis	3
FDSN 524	Fundamentals of Food Science	3
FDSN 531	HACCP Planning/Implementation	3
FDSN 593	Seminar on Food Safety & Tech (This course must be taken twice for one credit each time.)	2
Thesis Research		(6-8)
FDSN 591	Research and Thesis	6-8
Electives		(7-9)
Select seven to nine credit hours from the following:		7-9
FDSN 501	Nutrition, Metabolism & Health	3
FDSN 502	Develop, Deliver, Disseminate	3
FDSN 504	Food Biotechnology	3
FDSN 508	Food Product Development	3
FDSN 509	Biostatistics & Epidemiology	3
FDSN 510	Fund Biostats/Epidemiology Lab	1
FDSN 511	Food Law and Regulations	3

FDSN 519	Food Process Engineering Lab	3
FDSN 520	Low-Acid Canned Food Regs	3
FDSN 521	Food Process Engineering	3
FDSN 522	Adv Food Process Engineering	3
FDSN 523	Food Engineering Proc Delivery	3
FDSN 526	Engineering Principles of Food	3
FDSN 535	Perf Mgmt in Food Operation	3
FDSN 541	Principles of Food Packaging	3
FDSN 594	Special Projects	1-2
FDSN 597	Special Problems	1-4

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 two credit hours between both courses when enrolled in six credit hours of thesis; or one credit hour when enrolled in seven credit hours of thesis. However, if the FDSN 597 is used as a short course, the student can register up to four credit hours in FDSN 597 with FdSN adviser approval. Students may not enroll in FDSN 594 or FDSN 597 when using eight 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 80/515 (internet/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 two 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 Institute of Technology or other universities should consult with the faculty adviser as to how many credit hours may be transferred from their previous degree.

Code	Title	Credit Hours
Core Courses		(29)
FDSN 502/402	Develop, Deliver, Disseminate	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/Implementation	3
FDSN 610	Adv Topics Food Microbiology	2
FDSN 620	Adv Topics Food Chemistry	2
FDSN 630	Adv Topics Nutrition	2
FDSN 640	Adv Topics Food Process Engg	2
Seminar Requirement		(2)
FDSN 695	Research Seminar (taken twice)	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	Curr Topics in Funct'l Genomics	3
CHE 560	Ststcl Qlty Process Control	3
CHE 577	Bioprocess Engineering	3
CHEM 500	Advanced Analytical Chemistry	3
FDSN 501	Nutrition, Metabolism & Health	3
FDSN 504	Food Biotechnology	3
FDSN 508	Food Product Development	3
FDSN 511	Food Law and Regulations	3
FDSN 522	Adv Food Process Engineering	3
FDSN 523	Food Engineering Proc 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)
FDSN 691	Research and Thesis	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.

Code	Title	Credit Hours
Required Courses		(12)
FDSN 521	Food Process Engineering	3
FDSN 522	Adv 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/Implementation	3
FDSN 541	Principles of Food Packaging	3
Total Credit Hours		12

Gainful Employment Disclosure for Certificate in Food Process Engineering

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.

Code	Title	Credit Hours
Required Courses		(12)
FDSN 520	Low-Acid Canned Food Regs	3
FDSN 522	Adv Food Process Engineering	3
FDSN 523	Food Engineering Proc Delivery	3
FDSN 526	Engineering Principles of Food	3
Total Credit Hours		12

Gainful Employment Disclosure for Certificate in Food Processing Specialist

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.

Code	Title	Credit Hours
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/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	Appl Strat for Competitive Ent	3

Total Credit Hours 12

Gainful Employment Disclosure for Certificate in Food Safety and Industrial Management

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.

Gainful Employment Disclosure for Certificate in Food Safety and Technology

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.

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
FDSN 501	Nutrition, Metabolism & 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/Implementation	3
FDSN 541	Principles of Food Packaging	3
Total Credit Hours		12

Humanities

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Chair

Matthew Bauer

Director, Graduate Studies

Carly Kocurek

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 nine 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 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. 13) 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 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. 13) 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

- Master of Science in Technical Communication and Information Architecture (p. 444)
- Master of Science in Technology and Humanities (p. 445)
- Doctor of Philosophy in Technology and Humanities (p. 446)

Certificate Programs

- Instructional Design (p. 449)
- Technical Communication (p. 449)

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: 3 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. Focus 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 with min. grade of C

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 with min. grade of C

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* with min. grade of C or COM 541* with min. grade of C or COM 542* with min. grade of C, 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**

This course has variable content depending on the topic in communication chosen by the instructor. Topics may include the technical and cultural history of digital media, video games, academic writing, and humanities research methods.

Credit: Variable

COM 583**Social Networks**

This course will discuss a variety of measures and properties of networks, identify various types of social networks, 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 design. While the focus of the class will be on computer technology and programming languages, we will also look at humanization with regard to industrial design, engineering, 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 with min. grade of C

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.

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.

Credit: Variable

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 602**TA Seminar II**

This course helps prepare teaching assistants for their duties. TAs read and discuss articles sensitizing them to issues attendant to effective teaching. They practice teaching skills and techniques needed as they relate to undergraduates in their specific disciplines.

Lecture: 2 **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

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.

Coursework

33 credit hours beyond the bachelor's degree including:

- TCIA core (18 credit hours)
- Electives (minimum of nine credit hours)
- Project or thesis (minimum of three credit hours)

Examinations

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 six credit hours in one of the following courses: COM 594 or COM 591.

Code	Title	Credit Hours
Core Courses		(18)
COM 525	User Experience Research/Eval	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	Info 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 Project or Thesis		(3-6)
COM 594	Project ²	3-6
or COM 591	Research and Thesis M.S.	

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 three to six credit hours of COM 594; students pursuing the thesis option are required to take between three to six credit hours of COM 591.

Master of Science in Technology and Humanities

Coursework

33 credit hours beyond the bachelor's degree including:

- Technology and Humanities core (18 credit hours)
- Electives (minimum of 12 credit hours)
- Thesis or project (minimum of three credit hours)

Examinations

Thesis exam or project review

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 six credit hours in one of the following courses: COM 594 or COM 591.

Code	Title	Credit Hours
Core Courses		(18)
COM 521	Theory in Tech and Humanities	3
COM 538	Entrepreneurship in Tech Comm	3
COM 545	Writing for Acad Publication	3
COM 601	Resrch Mthds and Resources	3
COM 602	Qualitative Research Methods	3
or COM 603	Quantitative Research Methods	
HUM 610	Technology/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 (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 Project or Thesis		(3-6)
COM 594	Project ¹	3-6
or COM 591	Research and Thesis M.S.	

Minimum degree credits required: 33

¹ Students pursuing the project option are required to take between three to six credit hours of COM 594; students pursuing the thesis option are required to take between three to six credit hours of COM 591.

Communication and Media Studies

Code	Title	Credit Hours
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	Info Structure and Retrieval	3
COM 552	Gender & Technological Change	3
COM 553	Media and Globalization	3
COM 554	Science and Technology Studies	3
COM 571	Persuasion	3
COM 574	Communication in Politics	3

COM 577	Communication Law and Ethics	3
COM 584	Humanizing Technology	3

Linguistics

Code	Title	Credit Hours
COM 501	Intro to Linguistics	3
COM 506	World Englishes	3
COM 508	Structure of Modern English	3
COM 509	History of the Engl Language	3
COM 510	The Human Voice	3
COM 515	Discourse Analysis	3

Doctor of Philosophy in Technology and Humanities

Coursework

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)

Examinations

- Qualifying examination
- Comprehensive examination
- Dissertation proposal
- Dissertation (final thesis) examination

Transfer Credits

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

Code	Title	Credit Hours
Core Courses		(18)
COM 521	Theory in Tech and Humanities	3
COM 538	Entrepreneurship in Tech Comm	3
COM 545	Writing for Acad Publication	3
COM 601	Resrch Mthds and Resources	3
COM 602	Qualitative Research Methods	3
or COM 603	Quantitative Research Methods	
HUM 610	Technology/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, Philosophy, or Technical Communication 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

Code	Title	Credit Hours
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	Info Structure and Retrieval	3
COM 552	Gender & Technological Change	3
COM 553	Media and Globalization	3
COM 554	Science and Technology Studies	3
COM 571	Persuasion	3
COM 574	Communication in Politics	3
COM 577	Communication Law and Ethics	3
COM 584	Humanizing Technology	3

Linguistics

Code	Title	Credit Hours
COM 501	Intro to Linguistics	3
COM 506	World Englishes	3
COM 508	Structure of Modern English	3
COM 509	History of the Engl Language	3
COM 510	The Human Voice	3
COM 515	Discourse Analysis	3

Philosophy

Code	Title	Credit Hours
PHIL 551	Science and Values	3
PHIL 560	Ethics	3
PHIL 570	Engineering Ethics	3
PHIL 571	Ethics in Architecture	3
PHIL 573	Business Ethics	3
PHIL 574	Ethics in Computer Science	3
PHIL 580	Topics in Philosophy	3
PHIL 597	Special Problems in Philosophy	1-6
PHIL 691	Research and Dissertation	1-6

Technical Communication

Code	Title	Credit Hours
COM 503	Anal & Comm Quantitative Data	3
COM 511	Linguistics for Tech Comm	3
COM 523	Communicating Science	3
COM 525	User Experience Research/Eval	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	Info Structure and Retrieval	3
COM 542	Knowledge Management	3
COM 543	Publication Management	3
COM 561	Teaching Technical Comm	3
COM 571	Persuasion	3
COM 574	Communication 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 nine 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 mandatory doctoral advising meeting; 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.

Gainful Employment Disclosure for Certificate in Instructional Design

Curriculum

Code	Title	Credit Hours
Required Courses		(15)
COM 424	Document Design	3
or COM 528	Document Design	
COM 525	User Experience Research/Eval	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).

Gainful Employment Disclosure for Certificate in Technical Communication

Curriculum

Code	Title	Credit Hours
Required Courses		(12)
COM 424	Document Design	3
or COM 528	Document Design	
COM 525	User Experience Research/Eval	3
COM 425	Editing	3
or COM 529	Technical Editing	
Select a minimum of one course from the following:		3
COM 428	Verbal Visual Communications	3
COM 435	Intercultural Communication	3
COM 523	Communicating Science	3
COM 530	Standards-Based Web Design	3
Total Credit Hours		12

Physics

Robert A. Pritzker Science Center, Suite 182
 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 ready access to the expertise that the full faculty brings. In addition, the department offers a professional master's degree and a 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 of Physics has state-of-the-art computer and laboratory equipment, and conducts research in the areas of elementary particle physics, accelerator physics, condensed matter physics, biological physics, computational physics, and synchrotron radiation research including x-ray optics and x-ray imaging. Department faculty and staff have constructed and operate user facilities for x-ray scattering, XAFS 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; STM, AFM, and scanning electron microscope; a high-field nuclear magnetic resonance; Raman; UV-Vis; and Fourier transform infrared spectrometers. Laboratories for experimental research in biophysics, low-temperature, condensed matter physics, and particle and accelerator physics are active. Collaborative programs are carried on with Fermi National Accelerator Laboratory, Argonne National Laboratory, and the Advanced Photon Source. The department hosts or co-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 (CSRRRI).

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 unless specifically exempted based on academic achievement. Students may sit for the exam a limited number of times.

Admission Requirements

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

The Graduate Record Examination (GRE) is required for all applicants.

- Master's/Master of Science: 295 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 310 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

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 master's or M.S. comprehensive/Ph.D. qualifying examination.

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. 457)
- Master of Science in Applied Physics (p. 458)
- Master of Science in Physics (p. 459)
- Doctor of Philosophy in Physics (p. 460)

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. 35) in this bulletin.

Certificate Program

- Radiological Physics (p. 461)

Course Descriptions

PHYS 501

Methods of Theoretical Physics I

Vector analysis including curvilinear coordinates. Tensor algebra. Ordinary differential equations. Method of infinite series. Regular singularities, Frobenius method. First look at special functions. Gamma-, beta-, error functions. Airy function. Fourier series. Hilbert space, its basic properties. Sturm-Liouville theory. Orthogonal polynomials. Legendre, associated Legendre, Hermite, Laguerre etc. polynomials. Bessel functions, their properties, basic applications. Partial differential equations, their classification. Boundary conditions. Physical models with PDE. Separation of variables method, Cartesian system of coordinates. Separation of variables in cylindrical and spherical system of coordinates. Spherical functions. Fourier transform method.

Lecture: 3 Lab: 0 Credits: 3

PHYS 502

Methods of Theoretical Physics II

Group theory. Discrete groups, elementary examples and properties. Lie groups, Lie algebras, generators. Their fundamental properties. Group representations. $O(3)$, $SU(2)$, $SU(3)$, Lorentz groups and their applications. Complex variables: algebra, Cauchy-Riemann conditions, harmonic functions. Complex variables integrals: Cauchy theorem, Cauchy formula. Laurent series. Residues calculus: isolated singular points, poles, calculation of integrals using residues, other applications. Branches, singularities on the path of integration. Conformal mapping and its applications. Green functions. Their connection to complex variables calculus. Advanced, retarded, causal GF, application in physics. Integral equations.

Lecture: 3 Lab: 0 Credits: 3

PHYS 505

Electromagnetic Theory

Special relativity, its kinematics and dynamics. Lorentz transformations. 4D tensors and their algebra. Covariant formulation of electrodynamics. Electromagnetic field strength tensor, Maxwell equations. Gauge transformations and gauge invariance. Electrostatics, boundary value problems. Multipole expansion. Magnetostatics. Electric charge motion in an external electromagnetic field. Macroscopic electrodynamics. Electromagnetic waves. Dipole, quadrupole and magnetodipole radiation. Light scattering, radiation damping. Optics. Electromagnetic field of a relativistic charge. Synchrotron radiation. Vavilov-Cherenkov radiation.

Lecture: 3 Lab: 0 Credits: 3

PHYS 508

Analytical Dynamics

Hamilton's Principle, Lagrange's formalism, function, and equations. Invariance properties and conservation laws. One dimensional motion. Central force problem. Small harmonic oscillations. Nonlinear oscillations. Scattering theory. Rigid body motion. Non-inertial reference frames. Hamilton's formalism, function, and equations. Canonical transformations. Hamilton-Jacobi theory. Integrable systems and canonical perturbation theory.

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

Second quantization. Multiparticle systems. Applications of second quantization. Rotations and angular momentum. Angular momenta algebra. Group theory applications in quantum mechanics. Spin and spinors. Scattering theory. Particle in a magnetic field. Landau levels. Path integral formulation of classical and quantum mechanics. Relativistic quantum mechanics. Klein-Gordon equation. Multiparticle interpretation. Dirac equation. Gamma-matrices and their algebra. Bispinors. Gauge invariance in QM. Spontaneous symmetry breaking.

Prerequisite(s): (PHYS 405 with min. grade of C and PHYS 406 with min. grade of C) 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 patterning 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 525**Applied Physics Methods for Scientists and Engineers**

This is the first of a two-part course designed to provide science and engineering students with the opportunity to investigate the underlying physics and engineering principles governing challenging real-world problems or needs. Each student selects a topic based on her or his background and interest such as the development of novel or new scientific instruments, medical devices, consumer products, energy (conservation, transport, and storage) system, thermal management devices and systems, sustainability, etc.). Experimental, theoretical, numerical techniques or a combination thereof are used, as needed, in the development of new or improved designs, methodologies, systems, and solutions. No specific background is required other than curiosity, interest, and dedication.

Lecture: 3 Lab: 0 Credits: 3

PHYS 526**Applied Physics Case Studies for Scientists and Engineers**

This is the second of a two-part course designed to provide science and engineering students with the opportunity to investigate the underlying physics and engineering principles governing challenging real-world problems or needs. Each student selects a topic based on her or his background and interest such as the development of novel or new scientific instruments, medical devices, consumer products, energy (conservation, transport, and storage) system, thermal management devices and systems, sustainability, etc.). Experimental, theoretical, numerical techniques or a combination thereof are used, as needed, in the development of new or improved designs, methodologies, systems, and solutions.

Prerequisite(s): PHYS 525 with min. grade of B

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 405 with min. grade of C and PHYS 406 with min. grade of C) or PHYS 509 with min. grade of C

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 510* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

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 510 with min. grade of C and PHYS 509 with min. grade of C

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 510 with min. grade of C and PHYS 509 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

PHYS 550**Radiation Instrumentation Laboratory**

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 scalars to high speed multi-channel analyzers are used. Computer-linked instrumentation and computer-based applications are applied to practical problems.

Prerequisite(s): PHYS 571 with min. grade of C

Lecture: 1 Lab: 4 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 with min. grade of C

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.

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.

Lecture: 2 Lab: 0 Credits: 2

PHYS 567**Radiological Emergency Preparedness and Response**

This course is designed to provide students an introduction of the nature of the nuclear and radiological emergencies arising from either accidents or malicious acts, and the management actions in the preparedness and response. The lecture content is to familiarize students with emergency management guidance documents. It will focus on several aspects of emergency preparedness and response. In the process it will also include the recovery from the incident.

Lecture: 3 Lab: 0 Credits: 3

PHYS 568**Radiation Source Security and Management**

This course is designed to introduce radioactive sources that are currently used in all applications including defense, industry and medical areas. It will address the necessity to control and manage the licensed sources, particularly those designated by the International Atomic Energy Agency (IAEA) as Category I or II sources. The discussion will cover the potential consequences and impact of the lost sources either by lack of management or by theft. The course will also address the potential use of radioactive sources for malicious intents, such as for the radiological dispersal device (RDD, or "dirty bomb") or for the improvised nuclear device (IND).

Lecture: 3 Lab: 0 Credits: 3

PHYS 569**Seminars on Radiological Emergency Field Experience**

This course will provide a series of discussions on the practical aspects in radiological emergency management by acquiring experiences from speakers representing various organizations in the emergency management community across the federal, state and local level. It is intended to provide students with valuable experiences in radiological emergency preparedness and response.

Lecture: 3 Lab: 0 Credits: 3

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 of 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.

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 the 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 facilities/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 to address the underlying technical aspects. This course should be taken in a student's final semester.

Prerequisite(s): PHYS 571 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

PHYS 576**Radiation Dosimetry**

This course is designed 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 572 with min. grade of C

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**Intro 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 sample preparation, source preparation, and counting measurements.

Prerequisite(s): PHYS 550 with min. grade of C

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. 1. Actinide Chemistry Series 2. Environmental Radiochemistry/Bioassay 3. Nuclear Fuel Cycle Series 4. Nuclear Forensics 5. Radioelement Compounds.

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: 1 Lab: 0 Credits: 1

PHYS 591**Research and Thesis M.S.**

(Credit: variable) Prerequisite: Instructor permission required.

Credit: Variable**PHYS 594****Research Project**

Research project.

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:** 1 **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: 1 **Lab:** 0 **Credits:** 0**PHYS 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**SCI 595****Ethics for the Health Professions**

Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.

Lecture: 1 **Lab:** 0 **Credits:** 1

Master of Health Physics

The Professional Master's Degree in Health Physics offers three tracks designed for professionals working in energy, government, medicine, research, and industry. The program emphasizes the expertise of the instructors and the accrued knowledge of the profession. The curricula supplement technical depth in health physics with professional competencies in regulatory affairs, occupational health and safety, environmental analysis and assessment, complemented by common skills in project management, public communication, and leadership.

Curriculum

Code	Title	Credit Hours
Required Courses		(21)
PHYS 550	Radiation Instrumentation Lab	3
PHYS 561	Radiation Biophysics	3
PHYS 571	Radiation Physics	3
PHYS 572	Introduction to Health Physics	3
PHYS 573	Standards Statutes Regulations	3
PHYS 575	Case Studies Health Physics ¹	3
PHYS 576	Radiation Dosimetry	3
Health Physics Electives		(4)
Select a minimum of two courses from the following: ²		4
PHYS 566	Environmental Health Physics	2
PHYS 577	Operational Health Physics	2
PHYS 578	Medical Health Physics	2
Professional Electives		(6)
Select a minimum of two courses from the following:		6
MATH 525	Statistical Models and Methods	3
SCI 511	Project Management	3
SCI 522	Public Engagement Scientists	3
Total Credit Hours		31

¹ PHYS 575 should be taken in the final semester of study.

² One substitution for the articulated health physics electives may be chosen from the following courses with adviser and departmental approval: PHYS 567, PHYS 568, PHYS 569, PHYS 580, or PHYS 582.

A comprehensive examination is required for the degree, but the requirement will be waived for students who have completed all health physics courses (a total of 25 credit hours) with a GPA of 3.5/4.0 or above.

Master of Health Physics with Specialization in Radiochemistry

Code	Title	Credit Hours
Required Courses		(24)
PHYS 550	Radiation Instrumentation Lab	3
PHYS 561	Radiation Biophysics	3
PHYS 571	Radiation Physics	3
PHYS 573	Standards Statutes Regulations	3
PHYS 575	Case Studies Health Physics ¹	3
PHYS 580	Intro to Radiochemistry	3
PHYS 581	Radiochemistry Laboratory	3
PHYS 582	Applications of Radiochemistry	3
Health Physics Elective		(2-3)
Select a minimum of one course from the following:		2-3
PHYS 566	Environmental Health Physics	2
CHEM 509	Physicl Meths of Charztn	3
or PHYS 539	Phys Mthds of Characterization	
CHEM 512	Spectroscopic Methods II	2
Professional Electives		(6)

Select a minimum of two courses from the following:			6
MATH 525	Statistical Models and Methods	3	
SCI 511	Project Management	3	
SCI 522	Public Engagement Scientists	3	

Minimum degree credits required: 32

¹ PHYS 575 should be taken in the final semester of study.

Master of Health Physics with Specialization in Radiological Security, Emergency Preparedness and Response

Code	Title	Credit Hours
Required Courses		(21)
PHYS 550	Radiation Instrumentation Lab	3
PHYS 567	Radiological Emergency Prepare	3
PHYS 568	Radiation Source Security Mgmt	3
PHYS 569	Seminars on Radiological Emerg	3
PHYS 571	Radiation Physics	3
PHYS 572	Introduction to Health Physics	3
PHYS 575	Case Studies Health Physics ¹	3
Health Physics Electives		(5)
Select a minimum of five credit hours from the following: ²		5
PHYS 566	Environmental Health Physics	2
PHYS 580	Intro to Radiochemistry	3
PHYS 582	Applications of Radiochemistry	3
Professional Electives		(6)
Select a minimum of six credit hours from the following:		6
MATH 525	Statistical Models and Methods	3
SCI 511	Project Management	3
SCI 522	Public Engagement Scientists	3
Total Credit Hours		32

¹ PHYS 575 should be taken in the final semester of study.

² One substitution for the articulated health physics electives may be chosen from the following courses with adviser and departmental approval: PHYS 561, PHYS 573, PHYS 577, or PHYS 578.

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 degrees in engineering only require about one year of university physics, which is not enough to grasp the revolutionary 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 fundamental knowledge of physics is required. The fields of quantum optics and laser technology, semiconductor electronics, GPS and space science, nuclear energy, nanotechnology, materials science, and some areas of 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 modern 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

Code	Title	Credit Hours
Required Courses		(20)
PHYS 405	Fndmntls of Quantum Theory I	3
PHYS 406	Fndmntls of Quantum Theory II	3
PHYS 501	Meth 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&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 defense (optional)

Students interested in the thesis option must complete six to nine credit hours of PHYS 591 or PHYS 691.

Master of Science in Physics (Coursework Only Option)

Code	Title	Credit Hours
Required Courses		(18)
PHYS 501	Meth Theoretical Physics I	3
PHYS 505	Electromagnetic Theory	3
PHYS 508	Analytical Dynamics	3
PHYS 509	Quantum Theory I ¹	3
PHYS 510	Quantum Theory II	3
PHYS 515	Statistical Mechanics	3
Colloquium Requirement		(0-2)
Two semesters of colloquium coursework is required.		0-2
PHYS 585	Physics Colloquium (may be taken multiple times)	1
PHYS 685	Physics Colloquium (may be taken multiple times)	0
Electives		(9-14)
Select 9-14 credit hours		9-14

Minimum degree credits required: 32

Master of Science in Physics (Thesis Option)

Code	Title	Credit Hours
Required Courses		(18)
PHYS 501	Meth Theoretical Physics I	3
PHYS 505	Electromagnetic Theory	3
PHYS 508	Analytical Dynamics	3

PHYS 509	Quantum Theory I ¹	3
PHYS 510	Quantum Theory II	3
PHYS 515	Statistical Mechanics	3
Colloquium Requirement		(0-2)
Two semesters of colloquium coursework is required.		0-2
PHYS 585	Physics Colloquium (may be taken multiple times)	1
PHYS 685	Physics Colloquium (may be taken multiple times)	0
Thesis Research		(6-9)
PHYS 591	Research and Thesis M.S.	6-9
or PHYS 691	Research and Thesis Ph.D.	
Electives		(0-8)
Select zero to eight credit hours		0-8

Minimum degree credits required: 32

¹ The six-credit hour course sequence PHYS 405 and PHYS 406 may be substituted for PHYS 509 with adviser and departmental approval.

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. 560) of this bulletin for rules on how many credit hours may be transferred from another institution.

Code	Title	Credit Hours
Required Courses		(27)
PHYS 501	Meth Theoretical Physics I	3
PHYS 505	Electromagnetic Theory	3
PHYS 508	Analytical Dynamics	3
PHYS 509	Quantum Theory I ¹	3
PHYS 510	Quantum Theory II	3
PHYS 515	Statistical Mechanics	3
Select a minimum of three courses from the following:		9
PHYS 502	Methods of Theoretical Phys 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	Phys Mthds 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	Intro Synchrotron Radiation	3
Colloquium Requirement		(0-4)
Four semesters of colloquium coursework is required.		0-4
PHYS 585	Physics Colloquium (may be taken multiple times)	1
PHYS 685	Physics Colloquium (may be taken multiple times)	0
Elective Courses		(2-21)

Select 2-21 credit hours ²

2-21

Ph.D. Research**(24-36)**

PHYS 691

Research and Thesis Ph.D.

24-36

Minimum degree credits required: 72

¹ The six-credit hour course sequence PHYS 405 and PHYS 406 may be substituted for PHYS 509 with adviser and departmental approval.

² 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

Code	Title	Credit Hours
Required Courses		(6)
PHYS 571	Radiation Physics	3
PHYS 572	Introduction to Health Physics	3
Elective Courses		(6)
Select a minimum of six credit hours from the following: ¹		6
PHYS 550	Radiation Instrumentation Lab	3
PHYS 561	Radiation Biophysics	3
PHYS 566	Environmental Health Physics	2
PHYS 573	Standards Statutes Regulations	3
PHYS 576	Radiation Dosimetry	3
PHYS 577	Operational Health Physics	2
PHYS 578	Medical Health Physics	2
Total Credit Hours		12

¹ One substitution for the articulated electives may be chosen from the following courses with adviser and departmental approval: PHYS 567, PHYS 568, PHYS 580, or PHYS 582.

Gainful Employment Disclosure for Certificate in Radiological Physics

Psychology

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 312.567.3500
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Chair

Frank Lane

Associate Chair, Administration

Kristina Bauer

Associate Chair, Research

Patrick Corrigan

Director, Clinical Psychology

Gregory Chasson

Director, Industrial and Organizational Psychology

Scott Morris

Director, Counseling and Rehabilitation Science

Kelly Kazukauskas

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 firms. Today, the CRS supports and educates advanced graduate students to deliver high quality professional services such as assessing, developing, and leveraging the potential of clients' employees.

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.

The Chicago Health Disparities Center (CHDS) is a research group funded through the National Institute on Minority Health and Health Disparities (NIMHD) and Patient Centered Outcomes Research Institute (PCORI). Located at Illinois Institute of Technology and directed by Patrick Corrigan and Lindsay Sheehan, CHDC (chicagohealthdisparities.org), is committed to reducing health disparities for racial and ethnic minorities with mental illness. CHDC is partnered with Chicago area universities, service provider organizations, and public partners, including the Chicago Department of Public Health.

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, child social and emotional development, eating disorders, anxiety and repetitive behavior, and neuropsychological functioning. 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, cross-cultural issues, work-family interface, training and development, employee selection, employment discrimination, quantitative methods and psychometrics, occupational health, and humanitarian work psychology.

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 36 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 a M.S. in Industrial-Organizational Psychology 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 complete internships within various organizations where students are responsible for human resource management and development functions. Students in the industrial-organizational 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 Division of Counseling and Rehabilitation Science offers a M.S. in Rehabilitation and Mental Health Counseling, a Ph.D. in Rehabilitation Counseling Education, and a Ph.D. in combined clinical/rehabilitation psychology.

M.S. – Rehabilitation and Mental Health Counseling (RMHC): 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:

1. To 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. To 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. To prepare students for professional service and leadership within the fields of rehabilitation and mental health counseling.

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 counseling.

Ph.D. – Rehabilitation Counseling Education (RCE): The Rehabilitation Counseling Education Ph.D. program prepares individuals for careers in university teaching, research, and clinical practice with specific emphasis on rehabilitation counseling. The mission of the RCE Program at Illinois Tech is to offer a student-focused and research-based curriculum that prepares doctoral-level students to become professional counselor educators trained to perform advanced-level counseling, post-secondary teaching, clinical supervision, research, scholarship, leadership, and advocacy activities. The objectives of the program are:

1. To train Ph.D. level rehabilitation counselor educators who in turn will train clinical rehabilitation counselors to work with people with severe disabilities;
2. To provide students with a thorough grounding in rehabilitation and counseling philosophy, practices, research, processes, and ethics; and
3. To prepare students for professional service, leadership, and advocacy within the field of rehabilitation counseling education.

Students receive outstanding and intensive training in all aspects of rehabilitation counseling. The program seamlessly integrates teaching, research, and field-based experiences, providing first-rate practica and internship experiences to prepare students to become leaders in the field of rehabilitation counseling education.

The Division of Counseling and Rehabilitation Science has several funding opportunities to support students as they pursue their academic endeavors. Based on availability and with consideration of academic excellence, leadership potential in the field, and financial need, the following opportunities may be available:

- **RSA Scholarships:** 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.
- **Graduate assistantships:** The division has relationships with several departments within the university that provide part-time employment opportunities and partial tuition support to students within the Division of Counseling and Rehabilitation Science.
- **Teaching assistantships:** Students within the Division of Counseling and Rehabilitation Science may apply for teaching assistant positions during their second and subsequent years within their program.
- **The International and Multicultural Counseling Scholarship:** This scholarship specifically supports the academic endeavors of Division of Counseling and Rehabilitation Science students who demonstrate an interest in/passion for international and/or multicultural rehabilitation and mental health counseling issues.

Admission Requirements

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

298 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

Note: Degree/concentration requirements may exceed those listed here.

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 or a related field 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. GPA and test score requirements may be higher for some degrees or concentrations.

Degrees Offered

- Master of Science in Industrial-Organizational Psychology (p. 473)
- Master of Science in Psychology (p. 474)
- Master of Science in Rehabilitation and Mental Health Counseling (p. 475)
- Master of Science in Rehabilitation and Mental Health Counseling with Advanced Standing (p. 476)

- Doctor of Philosophy in Psychology with Specialization in Clinical Psychology (p. 477)
- Doctor of Philosophy in Psychology with Specialization in Clinical Psychology: Rehabilitation Track (p. 478)
- Doctor of Philosophy in Psychology with Specialization in Industrial-Organizational Psychology (p. 479)
- Doctor of Philosophy in Rehabilitation Counseling Education (p. 481)

Certificate Programs

- Psychiatric Rehabilitation (p. 482)
- Rehabilitation Counseling (p. 482)
- Rehabilitation Engineering Technology (p. 482)

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

Cognitive and Affective Bases

Critical overview of cognition, affect, and their intersection based on a variety of theories and approaches.

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).

Prerequisite(s): PSYC 533* with min. grade of C and PSYC 523 with min. grade of B, An asterisk (*) designates a course which may be taken concurrently.

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 533* with min. grade of C and PSYC 506 with min. grade of B, An asterisk (*) designates a course which may be taken concurrently.

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 546 with min. grade of C and PSYC 545 with min. grade of C

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 526 with min. grade of B

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 with min. grade of C

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 556 with min. grade of C and PSYC 529 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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**Theories of Psychotherapy**

Survey of 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**Meta-Analysis**

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.

Prerequisite(s): PSYC 511 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C and PSYC 557 with min. grade of C and PSYC 523 with min. grade of C

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 with min. grade of C

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 with min. grade of C or PSYC 546 with min. grade of C

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 556 with min. grade of C and PSYC 529 with min. grade of C

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* with min. grade of C, 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 influences 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 565**Grant Writing**

Grant support is needed for psychologists to set up and sustain state-of-the-art research programs. This course reviews all aspects of the successful grant writing using the NIH template as an example.

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

PSYC 581**Neuropsychological 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 with min. grade of C

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 584 with min. grade of C and PSYC 583 with min. grade of C

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 with min. grade of C

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: 1 Credits: 1

PSYC 600**Continuation of Residency**

Continuation of residency.

Lecture: 0 Lab: 1 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 conducting 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 546 with min. grade of C and PSYC 545 with min. grade of C

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**Assistive 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

Master of Science in Industrial-Organizational Psychology Curriculum

Code	Title	Credit Hours
Core Courses		(18)
PSYC 511	Psychometric Theory	3
PSYC 529	Personnel Selection&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		(3-6)
Select three to six credit hours from the following:		3-6
PSYC 558	Industrial Psyc Internship I	1-6
PSYC 559	Industrial Psych Internship II	1-6
Personnel Seminar		(3-6)
Select three to six credit hours from the following:		3-6
PSYC 517	Performance Appraisal Smr	3
PSYC 535	Personnel Selection	3
Organizational Seminar		(3-9)
Select three to nine credit hours from the following:		3-9
PSYC 531	Organizatnl Attitudes/Bhvr Sem	3
PSYC 532	Occupational Health Psychology	3
PSYC 580	Seminar in Leadership	3
I/O Elective Courses		(0-9)
Select zero to nine credit hours		0-9
PSYC 530	Meta-Analysis	3
PSYC 552	Legal Issues in Hmn Resrc Mgmt	3
PSYC 554	Survey;Multivariate Statistics	3
PSYC 571	Structural Equation Modeling	3
PSYC 588	Graduate Psychology Seminar	3
General Electives		(0-6)
Select zero to six credit hours		0-6
PSYC 502	Social Bases of Behavior	3
PSYC 503	Cognitive and Affective Bases	3
PSYC 504	Individual & Cultural Diffnrcs	3
PSYC 711	Multilevel Data Analysis	1.5
PSYC 714	Assessment Centers	1.5
PSYC 715	Orgnl Assesmnt & Planning	1.5
PSYC 720	Individual Assessment I/O Psyc	1.5
PSYC 721	Network Analysis	1.5
PSYC 722	Consulting Fundamentals	1.5
Any 500-level MBA course		3

Minimum degree credits required: 36

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

Code	Title	Credit Hours
Required Courses		(18)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Cognitive and Affective Bases	3
PSYC 504	Individual & Cultural Diffrences	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
Track requirements (Clinical and I-O)		(9)
Select nine credit hours		9
Thesis Research		(6)
PSYC 591	Research and Thesis M.S.	6
Total Credit Hours		33

The core four course sequence of PSYC 501- PSYC 504 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

Code	Title	Credit Hours
PSYC 506	Therapy I	3
PSYC 510	Clinical Assessment I	3
PSYC 526	Psychopathology	3
Total Credit Hours		9

Additional courses for I-O students

Code	Title	Credit Hours
PSYC 529	Personnel Selection&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 is fully accredited by the Council for Accreditation of Counseling and Related Programs (CACREP) for both clinical rehabilitation and clinical mental health counseling. This program 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, and the provision or coordination of evaluation, 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.

Core graduate coursework provides the basic knowledge and skills necessary to the fields of rehabilitation and mental health counseling. This includes counseling theory, rehabilitation and mental health counseling principles and practices, ethics, individual and group counseling, assessment, 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. Additionally, this program has a strong emphasis on psychiatric rehabilitation.

Concurrently, fieldwork 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, the VA, rehabilitation centers, mental health centers, medical hospitals, and other facilities for persons with mental health concerns and/or disabilities.

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 an option to take a reduced course load available, which is designed to meet the needs of the working professional. Courses are generally offered in the evening or 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.

This is a two-year, 60 credit hour program.

Curriculum

Code	Title	Credit Hours
Required Courses		(45)
PSYC 410	Intro Rehab/Mental Health Cslg	3
PSYC 411	Medcl Aspects of Dsblng Cond	3
PSYC 412	Multicultural/Psychosocial Iss	3
PSYC 513	Assess Rehab/Mental Hlth Cslng	3
PSYC 523	Theories of Psychotherapy	3
PSYC 526	Psychopathology	3
PSYC 547	Evidence-Based Practice	3
PSYC 557	Pre-Practicum Rehab/Mental Hlt	3
PSYC 561	Applied Counseling Techniques	3
PSYC 562	Job Placement	3
PSYC 563	Human Growth & Career Develop	3
PSYC 564	Rehab/Mental Health CnsIng Res	3
PSYC 583	Rehab Engineering Technology I	3
PSYC 588	Graduate Psychology Seminar (Addictions and Psychopharmacology)	3
PSYC 590	Psychiatric Rehabilitation	3
Community-Based Clinical Experience		(12)
PSYC 549	Practicum Rehab Mental Health	3
PSYC 578	Rehab Mntl Hlth Coun Intern I (Fieldwork)	6
PSYC 579	Rehab Mntl Hlth Coun Intern II (Supervision)	3
Research Project		(3)
PSYC 594 or PSYC 576	Special Projects Rsrch Rehab/Mental Hlth Couns	3

Total Credit Hours

60

There are several opportunities to apply for scholarships and traineeships, including an international and multicultural counseling scholarship based on merit and economic need.

Master of Science in Rehabilitation and Mental Health Counseling with Advanced Standing

60 credit hours

Project

Admission with advanced standing may allow a 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, and is usually completed over the course of two years. Advanced standing can be achieved in two ways: 1) as an external applicant who holds an acceptable undergraduate degree from a school either within or outside of the U.S. who has completed the equivalent of the first semester's required graduate-level courses; or 2) as a currently enrolled undergraduate student at Illinois Institute of Technology who has used electives to take courses within the graduate program. In both cases, the applicant must first meet the criteria for regular admission into the program in order to qualify for advanced standing.

Advanced Standing for External Applicants

This applies to external applicants who have already taken up to 15 credit hours of graduate-level rehabilitation and mental health counseling coursework at another university. Applicants must have already completed a B.S. or B.A. in psychology or a closely related field, or, if an international applicant, hold a relevant professional degree from outside the U.S. from an accepted university. If criteria for admission are met and the applicant wishes to transfer in courses to obtain advanced standing status, each course to be transferred will be evaluated to determine equivalency to one of our CACREP-accredited courses. 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 of their previous coursework, including projects and course syllabi, to determine eligibility for advanced standing. Candidates will be notified upon admission of their advanced standing status.

Advanced Standing for Currently Enrolled Undergraduate Students at Illinois Institute of Technology

Currently enrolled 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 their junior and senior years, qualified students can take up to 15 credit hours of graduate-level courses in the Rehabilitation and Mental Health Counseling program that will meet their undergraduate elective requirements, but will also count toward their Master of Science in Rehabilitation and Mental Health Counseling. For a course to be accepted towards advanced standing, the student needs to obtain a grade of "B" or better.

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 Psychological Science 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 their junior and senior year, and in consultation with the head of the division of counseling and rehabilitation science, students may take the following courses:

Code	Title	Credit Hours
PSYC 410	Intro Rehab/Mental Health Cslg	3
PSYC 411	Medcl Aspects of Dsblng Cond	3
PSYC 412	Multicultural/Psychosocial Iss	3
PSYC 513	Assess Rehab/Mental Hlth Cslng	3
PSYC 523	Theories of Psychotherapy	3
PSYC 562	Job Placement	3
PSYC 563	Human Growth & Career Develop	3
PSYC 564	Rehab/Mental Health CnsIng Res	3
PSYC 583	Rehab Engineering Technology I	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.

Doctor of Philosophy in Psychology with Specialization in Clinical Psychology

99 credit hours minimum

Comprehensive exam

Dissertation and oral defense

Internship (one 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. 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.

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

Code	Title	Credit Hours
Foundational Courses		(30)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Cognitive and Affective Bases	3
PSYC 504	Individual & Cultural Differences	3
PSYC 505	History and Systems of Psychology	3
PSYC 511	Psychometric Theory	3
PSYC 540	Research Methods	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
PSYC 554	Survey/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	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		(9)
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.		9
Master's Research Courses Applied to Elective Credit		(6)
PSYC 591	Research and Thesis M.S. ¹	6
Doctoral Research		(24)
PSYC 691	Research and Thesis Ph.D. ²	24

Minimum degree credits required: 99

- ¹ Students entering the program with a prior earned Master of Science degree in psychology with an empirically-based thesis may qualify for a waiver of the PSYC 591 thesis requirement (six credit hours). Please contact your academic adviser for more details.
- ² Up to three PSYC 600 credits can be substituted for PSYC 691 credits.

Doctor of Philosophy in Psychology with Specialization in Clinical Psychology: Rehabilitation Track

99 credit hours minimum
 Comprehensive exam
 Dissertation and oral defense
 Internship (one 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. 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 with specific interest in working with persons with disabilities and/or chronic illness may seek specialization within the rehabilitation track. The rehabilitation track requires practica in a rehabilitation-related setting. In addition, students complete three seminars (9 credit hours) 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, but grounds students in a rehabilitation philosophy. This philosophy includes a strengths-based, person-centered approach to treatment with an emphasis on advocacy and the empowerment of individuals to achieve their highest level of independence possible.

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: Rehabilitation Track Requirements

Code	Title	Credit Hours
Foundational Courses		(30)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Cognitive and Affective Bases	3
PSYC 504	Individual & Cultural Differences	3

PSYC 505	Hist and Systems of Psychology	3
PSYC 511	Psychometric Theory	3
PSYC 540	Research Methods	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
PSYC 554	Survey:Multivariate Statistics	3
Base Clinical Courses		(12)
PSYC 508	Ethics and Professnl Issues I	2
PSYC 509	Ethics and Professnl Issues II	1
PSYC 523	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
Rehabilitation Courses		(9)
PSYC 573	Psychosocial Bases:Dsbilty&Bhvr	3
PSYC 575	Adult Career Dev&Vocnl Bhvr	3
PSYC 588	Graduate Psychology Seminar	3
or PSYC 581	Neuropsychological Assessment	
Master's Research Courses Applied to Elective Credit		(6)
PSYC 591	Research and Thesis M.S. ¹	6
Research Courses		(24)
PSYC 691	Research and Thesis Ph.D. ²	24

¹ Students entering the program with a prior earned Masters of Science degree in psychology with an empirically-based thesis may qualify for a waiver of the PSYC 591 thesis requirement (six credit hours). Please contact your academic advisor for more details.

² Up to three PSYC 600 credits can be substituted for PSYC 691 credits.

Minimum degree credits required: 99

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

Code	Title	Credit Hours
Required Courses		(39)
PSYC 501	Biological Bases of Behavior	3
PSYC 502	Social Bases of Behavior	3
PSYC 503	Cognitive and Affective Bases	3
PSYC 504	Individual & Cultural Differences	3
PSYC 511	Psychometric Theory	3
PSYC 529	Personnel Selection & Evaluation	3
PSYC 545	Graduate Statistics I	3
PSYC 546	Graduate Statistics II	3
PSYC 554	Survey: Multivariate Statistics	3
PSYC 555	Seminar in Industrial Training	3
PSYC 556	Organizational Psychology	3
PSYC 558	Industrial Psych Internship I	3
PSYC 559	Industrial Psych Internship II	3
Personnel Electives		(6)
Select six credit hours from the following:		6
PSYC 517	Performance Appraisal Smr	3
PSYC 535	Personnel Selection	3
Organizational Electives		(6-9)
Select six to nine credit hours from the following:		6-9
PSYC 531	Organizational Attitudes/Bhvr Sem	3
PSYC 532	Occupational Health Psychology	3
PSYC 580	Seminar in Leadership	3
I/O Electives		(3-15)
Select 3-15 credit hours from the following:		3-15
PSYC 530	Meta-Analysis	3
PSYC 552	Legal Issues in Hmn Resrc Mgmt	3
PSYC 571	Structural Equation Modeling	3
PSYC 588	Graduate Psychology Seminar ¹	3
General Electives		(0-9)
Select zero to nine credit hours from the following:		0-9
PSYC 711	Multilevel Data Analysis	1.5
PSYC 714	Assessment Centers	1.5
PSYC 715	Orgnl Assesmnt & Planning	1.5
PSYC 720	Individual Assessment I/O Psyc	1.5
PSYC 721	Network Analysis	1.5
PSYC 722	Consulting Fundamentals	1.5
Any 500-level MBA course ²		3
Master's Research Courses Applied to Elective Credit		(0-8)
PSYC 591	Research and Thesis M.S.	0-8
Research Courses		(24-32)
PSYC 691	Research and Thesis Ph.D.	24-32

Minimum degree credits required: 96

¹ This topics course may be taken multiple times if the content differs. Students should consult with their adviser on the appropriateness of the course content for their program of study.

² Students should consult with their adviser on the appropriateness of the course content for their program of study.

Doctor of Philosophy in Rehabilitation Counseling Education

78 credit hours minimum

Qualifying exam

Comprehensive exam

Dissertation and oral defense

The Rehabilitation Counseling Education PhD program is fully accredited by the Council for Accreditation of Counseling and Related Programs (CACREP) in the area of Counselor Education and Supervision. The purpose of the program is to train doctoral-level students to become professional counselor educators who are proficient in the following areas: advanced-level counseling, post-secondary teaching, clinical supervision, research, scholarship, leadership, and advocacy. This program offers a student-focused and research-based curriculum that prepares leaders in the field of rehabilitation counseling at the highest level. Illinois Institute of Technology faculty view rehabilitation counseling as a specialized area of professional counseling practice in which the major goal is to assist a person with a disability or chronic illness to move to psychological and economic independence.

The program of study provides for the equivalent of two years (four semesters) of full-time coursework and supervised experience, in addition to the completion of dissertation research. Students generally enter the program having already completed a 60 credit-hour master's degree in rehabilitation counseling or closely related field (preferably from a CACREP-accredited program). Students who have not met these criteria may have their coursework evaluated for equivalency and may be able to make up any deficiencies prior to beginning their doctoral-level coursework.

Within the program, students take 54 credit hours of coursework (15 of which can be transferred from a qualifying master's degree program) plus 24 credit hours of dissertation work. Students must successfully pass both an oral qualifying exam and a written comprehensive exam.

Curriculum

Code	Title	Credit Hours
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/Multivariate Statistics	3
Rehabilitation Core		(9)
PSYC 566	Addictive Behavior/Behavior Ch	3
PSYC 577	Professional & Ethical Issues	3
PSYC 588	Graduate Psychology Seminar	3
Experiential Components of Rehabilitation Counseling Education		(9)
PSYC 549	Practicum Rehab Mental Health	3
PSYC 586	Concepts of Supervision	3
PSYC 588	Graduate Psychology Seminar (Curriculum Development and Practice Teaching)	3
Internships		(9)
Students are required to complete three internships that total 600 hours in three of the following areas: research, teaching, supervision, counseling, and/or leadership and advocacy.		
PSYC 589	Rehab Internship III	9
Elective Courses		(15)
Select 15 credit hours from the following courses:		15
PSYC 411	Medcl Aspects of Dsbling Cond	3
PSYC 513	Assess Rehab/Mental Hlth Cslng	3
PSYC 523	Theories of Psychotherapy	3
PSYC 526	Psychopathology	3
PSYC 547	Evidence-Based Practice	3
PSYC 561	Applied Counseling Techniques	3
PSYC 562	Job Placement	3
PSYC 563	Human Growth & Career Develop	3
PSYC 564	Rehab/Mental Health CnsIng Res	3
PSYC 583	Rehab Engineering Technology I	3

PSYC 590	Psychiatric Rehabilitation	3
Research Courses		(24)
PSYC 691	Research and Thesis Ph.D.	24
Total Credit Hours		78

Certificate in Psychiatric Rehabilitation Curriculum

Code	Title	Credit Hours
Required Courses		(9)
PSYC 526	Psychopathology	3
PSYC 588	Graduate Psychology Seminar	3
PSYC 590	Psychiatric Rehabilitation	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Psychiatric Rehabilitation

Certificate in Rehabilitation Counseling Curriculum

Code	Title	Credit Hours
Required Courses		(16-21)
PSYC 410	Intro Rehab/Mental Health Cslg	3
PSYC 513	Assess Rehab/Mental Hlth Cslng	3
Select one course from the following:		3
PSYC 523	Theories of Psychotherapy	3
PSYC 557	Pre-Practicum Rehab/Mental Hlt	3
Select one course from the following:		3
PSYC 562	Job Placement	3
PSYC 563	Human Growth & Career Develop	3
PSYC 575	Adult Career Dev&Vocnl Bhvr	3
Select one course from the following:		3
PSYC 411	Medcl Aspects of Dsbling Cond	3
PSYC 588	Graduate Psychology Seminar	3
Select one course from the following:		1-6
PSYC 578	Rehab Mntl Hlth Coun Intern I	1-6
PSYC 599	Clinical Internship	1-6

Minimum certificate credits required: 21

Gainful Employment Disclosure for Certificate in Rehabilitation Counseling

Certificate in Rehabilitation Engineering Technology Curriculum

Code	Title	Credit Hours
Required Courses		(9)
PSYC 583	Rehab Engineering Technology I	3
PSYC 584	Rehab Engineering Tech II	3
PSYC 585	Rehab Engg Technology III	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Rehabilitation Engineering Technology

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Program Contacts

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M. Krishna Erramilli

Master of Mathematical Finance
Tomasz Bielecki

Master of Public Administration
Roland Calia

Master of Technological Entrepreneurship
M. Krishna Erramilli

M.S. in Environmental Management and Sustainability
Roland Calia

M.S. in Finance
John F. O. Bilson

M.S. in Management Science
Siva K. Balasubramanian

M.S. in Marketing Analytics
M. Krishna Erramilli

Ph.D. in Management Science
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. The Stuart School is committed to creating well-rounded students who are equipped with expert academic knowledge, and also possess the interpersonal skills and professional experiences that are critical to academic and career success. The school is dedicated to continuing to offer opportunities to Stuart's diverse faculty, staff, student, and community populations—not only in the Chicago area but also globally. Our mission states: The Stuart School combines rigorous, relevant, and interdisciplinary academic and practice-oriented research and education. Our approach results in thought leadership and advances students' careers in technologically-oriented private and public sector industries worldwide.

Established in 1969 with a gift from Illinois Institute of Technology alumnus and Chicago financier Harold Leonard Stuart, the Stuart School of Business 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 co-terminal programs with various undergraduate majors at Illinois Tech.

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.

Academic support and career development are very important at Stuart. The business school provides academic support through the Office of Academic Affairs and Advising, enables students to find professional success through the Stuart Career Management Center, and provides career readiness training through Stuart's unique co-curricular requirements, the Advancing Career and Education (ACE) workplace immersion program, and the Professional Communication Advancement (PCA) program.

Stuart operates on a semester academic calendar consisting of two semesters beginning in August and January and summer sessions that enroll between May and August. Because many Stuart students work full time, graduate classes are regularly offered on weekday evenings along with some daytime courses.

Research at Stuart

Faculty at the Stuart School of Business engage in rigorous, relevant, and interdisciplinary academic and practice-oriented research. 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 Associate Dean Siva Balasubramanian at sivakbalas@stuart.iit.edu.

The Center for Corporate Performance

The Center for Corporate Performance (CCP) was formed in order to take a "Big Data" approach to understanding the relationships between corporate organization structure, governance policies, and economic and financial performance metrics. CCP's goal is to bridge the gap between research in management, organization, and policy and research in economics and finance. CCP also hopes to bridge the gap between academic research and professional practice, and to be able to speak to both academics and CEO's in a language that both can understand.

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.

The Center for Strategic Finance

The Center for Strategic Finance focuses on strategy in financial markets as a new discipline, building upon theoretical concepts drawn from traditional finance, strategic management, game theory, and computer science. CSF fellows are asking new questions about financial markets in light of the quantification (and automation) of trading, execution, and risk management strategies. They are developing new theories that are shaping the future of finance. There is no better place to study strategic finance than Chicago, which is a primary location for the research and development of strategies in financial markets.

Dual Degree Programs

Several dual-degree programs are offered, including programs in which students are eligible to earn a law degree from Chicago-Kent College of Law or a Master of Design from the Institute of Design. 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 Institute of Design and 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. Environmental Management and Sustainability, M.S. Finance, M.S. Marketing Analytics)

Combine your Master of Business Administration with one of our specialized M.S. degree programs in environmental management and sustainability, finance, or marketing analytics. 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. Environmental Management and Sustainability/J.D.

The Master of Science in Environmental Management and Sustainability/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.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.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 Analytics concentration: a graduate degree considered equivalent to the M.S. in Marketing Analytics degree offered at the Stuart School
2. M-track with Quantitative Finance concentration: a graduate degree considered equivalent to the M.S. in Finance degree offered at the Stuart School
3. UG-track with Analytics or Quantitative Finance 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. 517)
- Master of Public Administration (p. 522)
- Master of Technological Entrepreneurship (p. 524)
- Master of Science in Environmental Management and Sustainability (p. 524)
- Master of Science in Finance (p. 525)
- Master of Science in Management Science (p. 526)
- Master of Science in Marketing Analytics (p. 527)
- Doctor of Philosophy in Management Science (p. 527)

Dual Degree Programs

- M.B.A./Master of Public Administration
- M.B.A./M.S. in Environmental Management and Sustainability
- M.B.A./M.S. in Finance
- M.B.A./M.S. in Marketing Analytics

With the Institute of Design

- Master of Design/Master of Business Administration (p. 384)
- Master of Design/Master of Public Administration (p. 386)

With the Chicago-Kent College of Law

- M.B.A./J.D. (p. 234)
- Master of Public Administration/J.D. (p. 234)
- M.S. in Environmental Management and Sustainability/J.D. (p. 234)
- M.S. in Finance/J.D. (p. 234)

Joint Degree Program

- Master of Mathematical Finance (with Applied Mathematics) (p. 520)

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 Applied Mathematics/Master of Mathematical Finance
- 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 Chemistry/Master of Science in Environmental Management and Sustainability
- 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

- Compliance and Pollution Prevention (p. 531)
- Corporate Finance (p. 531)¹
- Economic Development and Social Entrepreneurship (p. 531)
- Financial Economics (p. 532)¹
- Financial Modeling (p. 532)¹
- Financial Toolbox (p. 532)
- Fundamentals of Finance (p. 532)
- Innovation and Emerging Enterprises
- Investments (p. 533)¹
- Marketing Management
- Nonprofit and Mission-Driven Management (p. 533)
- Public Management (p. 533)
- Risk Management (p. 534)¹
- Security, Safety, and Risk Management (p. 534)
- Sustainable Enterprise (p. 535)
- Trading (p. 535)¹

¹ Post-graduate

Course Descriptions

BUS 510

Strategy & Innovation

The 21st century business environment has become increasingly volatile, uncertain, complex and ambiguous. Competing and succeeding in such an environment requires new and innovative thinking. In this course you will learn how the global business environment has been transformed over the past few decades, how companies are redefining their purpose and how they are applying innovative thinking to their strategy and business models.

Lecture: 3 Lab: 0 Credits: 3

BUS 550

Business Statistics

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 Strategy Capstone Project

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 with min. grade of C and MBA 513 with min. grade of C and MBA 509 with min. grade of C

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: 6 Credits: 3

EMS 501

Environmental Policy

Environmental policies, the main tools that governments use to achieve environmental goals, cut across a wide swath of pollutants, industries, academic theory, scientific evidence, politics, 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 for hundreds of other goals. 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 governments often use to address environmental issues, the political processes involved in the environmental policymaking 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.

Lecture: 3 Lab: 0 Credits: 3

EMS 502

Environmental Law

In this course, we will study major U. S. environmental laws which also became the models for environmental laws for many other nations. We will become acquainted with the most important requirements of these laws and explore how they are administered in practice. Using case studies, we will discuss the rights and responsibilities of regulators, regulated entities, and members of the public under these laws. Finally, we will examine how these laws have adapted to address new challenges like global climate change.

Lecture: 3 Lab: 0 Credits: 3

EMS 503

Environmental Pollution Control

This course examines interactions between economic growth and the environment (implications of environmental externalities) and the application of environmental-economic models and technological innovations for managing environmental pollution resulting from economic development activities. Tools and techniques specific for design of environmental management systems are discussed while emphasizing on the importance of analytic tools for proper process mapping, I/O analysis, data collection/analysis, data interpretation, and pollution mapping/reporting. The importance of technological innovations and entrepreneurial activities such as design of companies within companies (CWC) is presented for sustainable design of environmental pollution prevention/control strategies and policies in the areas of solid waste, water/wastewater, air pollution (both particulate and gases/GHGs) management, and climate change. This course emphasizes on the importance of technological innovations, process mapping, and numerical exercises for broadening the insights needed to permit implementation of pollution abatement and control strategies for organizational sustainability.

Lecture: 3 Lab: 0 Credits: 3

EMS 504**Industrial Ecology**

This course introduces students to the emerging field of industrial ecology and examines how this systems-based approach can be used to move society toward a more sustainable future. Industrial ecology is an interdisciplinary field involving technology (science and engineering), public policy, business administration, and, increasingly, the social sciences. The course introduces strategies and tools such as material and energy flow analysis, life cycle assessment, design for the environment, extended producer responsibility, and industrial symbiosis. Both individual assignments and team projects are a significant part of the learning experience in this course.

Lecture: 3 Lab: 0 Credits: 3

EMS 505**Environmental Economics and Finance**

The emerging field of environmental finance involves the art and science of using economic incentives, financial tools and market mechanisms to achieve desired environmental outcomes. This course illuminates the role economic theory and, more broadly, economic thinking can play in informing and improving environmental policy. Economics is central to understanding why environmental problems arise and how and why to address them. An understanding of markets – why they work, when they fail, and what lessons they offer for the design of environmental policies and the management of natural resources – is central to an understanding of environmental issues. But even before we start thinking about how markets work, it is useful to begin with a more basic question: What is environmental economics? The historical evolution and current developments of market-based mechanisms to address environmental issues will be analyzed. Lessons from environmental markets for acid rain and domestic and international greenhouse gas emissions will be discussed at length. Other environmental markets (smog, renewable energy, water, sustainability indices, and biodiversity) will also be covered.

Lecture: 3 Lab: 0 Credits: 3

EMS 511**Solid and Hazardous Waste Management**

The aim of the course is to teach the modern multi-faceted approach of the management of solid and hazardous waste. At the conclusion of class, students should be able to suggest options for waste reduction at source so as to reduce quantities of waste generated, have an array of options to turn waste into economic goods, be able to suggest prevention, treatment, and disposal methods for waste from which the value has been taken out, and have a general feeling for financial aspects in solid and hazardous waste management as well as be able to distinguish the key players in the solid waste field.

Lecture: 3 Lab: 0 Credits: 3

EMS 512**Environmental Risk Assessment**

This course recognizes the necessity for design of strategic management strategies that can create balance between societal welfare and successes of the organizations. Focusing on the design of CSR strategies, this course evaluates tools and techniques applicable to addressing both the positive and negative impacts of business activities on organizations' internal and external stakeholders including, but not limited to, those associated with environmental, occupational, and ecological risks. While analyzing management tools specific to inducing social responsibility throughout the organization, course emphasizes on the alignment between strategic management of employees and community welfare and organizations' business objectives and performance. The need for developing a business case for CSR is highlighted in order to evaluate potential impacts of CSR before investing capitals or making any business decisions. Utilizing specific reporting requirements, course emphasizes the importance of proper reporting and communication of CSR activities and impacts on organizations performance to capital markets, shareholders, and other stakeholders.

Lecture: 3 Lab: 0 Credits: 3

EMS 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

EMS 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 major social and environmental challenges around the world by highlighting both local and international social ventures. 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 (economic, 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 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 to improve their impact.

Lecture: 3 Lab: 0 Credits: 3

EMS 532**Environmental and Energy Law Clinic**

The Environmental and Energy Law Clinic offers a clinical opportunity for students in Stuart's EMS Program. It is also a part of the legal practice of the Chicago Legal Clinic, Inc. Because it is a clinical experience, students will have obligations different from those in most classes. Most important from a professional perspective, clinic cases are professional obligations of the Chicago Legal Clinic, which represents the community organizations for which students are working. Therefore, you have an ethical responsibility to third parties to produce high-quality, timely work product beyond the normal expectations that go along with completing work for a class.

Lecture: 3 Lab: 0 Credits: 3

EMS 541**Sustainable Energy Systems**

This course attempts to identify and evaluate issues and benefits of industrial sustainable transitions and their relations to the flow of energy and money through the economy. The importance of the energy and resources supplied to the economy by energy transformation systems are presented while considering management of the environmental externalities of energy use bound by technological and resource constraints. Development of sustainable energy systems, considerations of the alternative energy production to substitute for fossil fuels, and evaluations of the end use and the upstream effects of the energy demands are considered while supporting the notion of transitional engineering for sustainability.

Lecture: 3 Lab: 0 Credits: 3

EMS 542**Economics of Energy Systems**

This course addresses the finance and economics of energy and covers the principles and tools necessary to conduct sound decision-making and analysis. It will guide students to achieve a strong foundation in leading best practices that apply to the field of energy finance and economics. New energy markets are developing, and environmental regulation is targeting the energy sectors. As a result, it is critical to understand the fundamentals of how these markets operate so that optimal energy policy can be designed.

The course is designed into the following sections: an overview of energy finance and economics; financial and economic analysis in the energy industry; and energy risk management and related topics.

Lecture: 3 Lab: 0 Credits: 3

EMS 543**Environmental Compliance and Regulation**

This course is designed to give students a detailed understanding of the requirements and practices involved in carrying out a successful, long term environmental compliance program for industrial and commercial facilities. It builds on students' basic understanding of the underpinning environmental statutes and regulations.

Lecture: 3 Lab: 0 Credits: 3

EMS 550**Business Analytics**

This course covers statistics tools that are critical for managers in enabling their firms to have a competitive advantage. The course includes descriptive statistics, probability, sampling, estimation, hypothesis testing, linear regression, ANOVA, time-series, and goodness-of-fit tests. The models address problems in a variety of business functional areas and business processes. 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

EMS 590**Business Innovation in the Next Economy**

This is the capstone course for the EMS Program. The goal of the course is to help future senior executives understand how firms compete in a global marketplace and society and how they make money by creating sustainable competitive advantage. Essentially, this involves creating an alignment or fit between the organization and trends in the next economy/marketplace, the definition and strategy of the firm, and the firm's organizational structure. We will refer to this as the business model which both tells the story of the business and analyze the numbers to show that the story can make a profit. The course will emphasize an integrated view of the firm and the connections between and among the various functions and levels of activity in the firm as well as its relationships and interactions with other players including rivals, suppliers, customers, regulators, and the public. Most cases will take the point of view from the top management/CEO of the firm, but it is the behavior of the firm that we are interested in.

Lecture: 3 Lab: 0 Credits: 3

EMS 595**Special Topics in Environmental Management and Sustainability**

This course is a client-focused, project-based course in which students apply the knowledge and skills they have acquired throughout the program by working on projects related to the sustainability issues facing the client organization.

Lecture: 3 Lab: 0 Credits: 3

EMS 599**Independent Study in Environmental Management & Sustainability**

Student will conduct independent research on an environmental management and sustainability topic.

Credit: Variable

MAX 501**Digital Marketing**

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 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 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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MAX 504**Marketing Strategy**

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): MAX 501 with min. grade of C and BUS 510 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MAX 506**Database Design and SQL**

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 507**Visual Analytics - Data Analytics & Visualization**

This course provides an introduction as well as hands-on experience in data visualization. It introduces students to design principles for creating meaningful displays of quantitative and qualitative data to facilitate managerial decision-making. Analytics involves the extensive use of computer applications, data (both "big" and "small"), and quantitative methods to help drive business decisions. Students will learn essential theories, concepts, methodologies, and use leading computer tools to visualize and analyze real world data.

Lecture: 1 Lab: 2 Credits: 1

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 Research Methods**

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MAX 525**Cognitive Computing and AI**

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 with min. grade of C

Lecture: 2 Lab: 1 Credits: 3

MAX 526**Quantitative Marketing Models**

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 with min. grade of C

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: 3 Credits: 3

MBA 501**Financial Statement Applications**

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**International Trade**

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 2016; (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**Microeconomics 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 and Organization Design**

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 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): MBA 501 with min. grade of C and BUS 510 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MBA 511**Marketing Strategy**

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 with min. grade of C

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 overall 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 with min. grade of C

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 with min. grade of C and MBA 509 with min. grade of C and MBA 505 with min. grade of C

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**Human Capital Management**

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MBA 526**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 value 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**Management of Innovation and Technology**

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 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MBA 564**Global Business Strategy**

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MBA 569**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 Abroad**

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MBA 576**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 with min. grade of C

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 with min. grade of C

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 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, 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 with min. grade of C

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**Mathematics for Management Science I**

This is the first of a two-semester sequence in advanced-level mathematical economics. It introduces students to economic models, microeconomics theory, equilibrium analysis and optimization problems. The course examines various market settings such as competitive markets, oligopolies, and monopolies; the course addresses contexts involving the firm decision making under uncertainty, and game theory. Focus is on major topics of economic analysis and the tools used to study them. Some mathematics background, particularly calculus and matrix algebra, is essential.

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

MSC 512**Statistics for Management Science I**

This course provides a comprehensive introduction to econometrics; linear, nonlinear, semiparametric and nonparametric regression, popular distributions, confidence intervals and joint confidence intervals, hypothesis testing, sample size and power, functional form and structure, endogeneity and instrumental variables estimation, systems of equations, models of panel data, maximum likelihood estimation, likelihood ratio tests, generalized method of moments, simulation based estimation and random parameter models. It will also focus on the mathematics of differential equations, stationary time series models, conditional heteroscedasticity, non-stationary time series, co-integration 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 and become familiar in using STATA and other advanced statistical software and research 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**Mathematics for Management Science II**

This is the second course in the two-course sequence in mathematical economics. It focuses on optimization problems in addition to discussing nonlinear programming, Kuhn-Tucker conditions, and dynamic analysis. In addition, it continues discussion on game theory and explores its use in modern economics and business through examinations of classic and current papers. Students are also introduced to models used in modern macroeconomics.

Prerequisite(s): MSC 511 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSC 515**Statistics for Management Science II**

The course introduces Bayesian estimation, and emphasizes simulation-based inference, statistical computing, discrete choice, limited dependent variables (truncation, censoring and sample selection), time series analysis including advanced forecasting techniques. This course intends to integrate modern theories and empirical applications in a manner that many useful tools will be discussed. The course is heavily project oriented and is organized around Big Data applications and statistical packages. Students will be expected to work with modern statistical packages and large datasets.

Prerequisite(s): MSC 512 with min. grade of C

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 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSC 517**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

MSC 518**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 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.

Lecture: 3 Lab: 0 Credits: 3

MSC 544**Equity Valuation**

The primary goal is for students to develop an understanding of equity valuation processes and applications. Topics discussed in class will include dividend discount, free cash flow, residual income, and market-based valuations as well as private and distressed company valuations. Throughout this course, students will apply equity asset valuation topics discussed in class to real world examples and in-class problems/exercises. During the latter part of this course, students will work in a group environment to complete and present an equity research report for a selected U.S. public company. Because this is a "hands on" course, it will require both the student's attendance and participation to learn the core concepts that are necessary to perform well on the class exams and apply to the group equity valuation project.

Lecture: 3 Lab: 0 Credits: 3

MSC 554**Market Risk Management**

The course focuses on market risk of financial institutions. It starts with interest rate risk and asset liability management, and then moves to measurement of VaR for both fixed income securities and equity. The second part of the course focuses on banks' market risk management, earnings at risk, and economic value of equity. Finally, regulation, compliance, and standardized regulatory models are discussed. Background knowledge of valuations and statistics. Financial modeling using Excel and a comfortable ability to handle algebra and arithmetic will be very helpful.

Lecture: 3 Lab: 0 Credits: 3

MSC 555**Credit Risk Management**

The course focuses on the various issues related to credit risk management. These include probability of default modeling; banking institutions' financial management; economic capital analysis, and bank regulations. For bank regulations, we will cover Basel I, II, III, and CCAR. Probability of default estimations and stress testing will be implemented with real data.

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 515 with min. grade of C and MSC 512 with min. grade of C

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 611 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSC 613**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.

Lecture: 3 Lab: 0 Credits: 3

MSC 614**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.

Lecture: 3 Lab: 0 Credits: 3

MSC 615**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.

Lecture: 3 Lab: 0 Credits: 3

MSC 616**Social Media Marketing Analytics**

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 with min. grade of C

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 631 with min. grade of C and MSC 512 with min. grade of C

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 511 with min. grade of C

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 631 with min. grade of C and MSC 605 with min. grade of C

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 separable 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 515 with min. grade of C and MSC 512 with min. grade of C

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 515 with min. grade of C and MSC 512 with min. grade of C

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 with min. grade of C and MSC 515 with min. grade of C and MSC 514 with min. grade of C and MSC 512 with min. grade of C

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 with min. grade of C and MSC 512 with min. grade of C and MSC 516 with min. grade of C and MSC 514 with min. grade of C and MSC 515 with min. grade of C and MSC 513 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSC 655**Advanced Analytics for Decision Making**

This course has the following objectives: (a) to teach students the link between analytics and business value; (b) to expose students to techniques useful for visualizing and for drawing insights from complex data; (c) to introduce methods for both gaining insights from historical data (descriptive data mining) and predicting possible future outcomes (predictive data mining); (d) to enable students to use decision analysis to develop an optimal strategy when faced with several decision alternatives given risk-preferences and uncertain event outcomes; and (e) to improve students' critical thinking skills.

Lecture: 3 Lab: 0 Credits: 3

MSC 691**Research and Thesis PhD**

Credit: Variable

MSC 697**Special Research Issues**

This course is in lieu of MSC 691 that PhD-MSC legacy students can register for after they have already completed the MSC 691 credit requirements for graduation.

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 with min. grade of C and MSF 503 with min. grade of C and MSF 502 with min. grade of C

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 with min. grade of C and MSF 503 with min. grade of C and MSF 502 with min. grade of C

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 with min. grade of C and MSF 503 with min. grade of C and MSF 502 with min. grade of C

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 505 with min. grade of C

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 Heath-Jarrow-Morton model and market rate models. Students will implement these term structure models in Excel/VBA and Matlab.

Prerequisite(s): MSF 505 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

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 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSF 547**Machine Learning for Financial Markets**

In this class, students study machine learning as it is applied in the financial industry. Importantly, the focus of the course is on understanding performance evaluation of machine learning algorithms in algorithmic trading and alpha-generation environments. Significant time is spent on data cleaning, preprocessing, and dimension reduction. Algorithms studied include supervised learning for regression and classification, such as logistic regression, decision trees, and naïve Bayes, k-nearest neighbors, and support vector machines. Ensemble algorithms LightGBM and XGBoost are also covered in detail. Then, a significant portion of the course is dedicated to neural networks and deep learning. Students learn-by-doing using Python to build scripts that use real-world data to build hands-on understanding. Further, students are encouraged to develop independent projects suitable to presentation at job interviews.

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 505 with min. grade of C and MSF 504 with min. grade of C

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 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

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 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

Lecture: 3 Lab: 3 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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSF 568**Energy Commodities Analytics and Trading**

Energy commodities and derivatives are very important in the real economy and financial markets. Business students who are interested in trading, analytics, and financial risk management should pay attention to energy markets. In addition, some engineering/science students would like to widen their comfort zone to financial/commodity markets, which may be their future employers. This three-credit course is designed for such business, engineering, and science Master's students. This course introduces energy markets, discusses trading for speculative, arbitrage, and hedging purposes, and provides a systematic exposition of data-driven analytic models for energy prices and other risk factors. At the end of this semester, students will be able to help research, propose, and implement hedging/trading strategies in energy markets. Beyond reading materials and attending lectures, students will also work on in-class exercises and homework assignments consisting of paper-and-pencil problems and computer programming tasks. Through a term project, students will work on a carefully-designed practical problem, gain hands-on experience of programming for trading and financial risk management, and write a white paper. A white paper in this kind of course serves as an effective marketing tool for job search purposes. The aforementioned in-class exercises and homework assignments will provide various guidance for the term project. The learning objectives of this course is in line with the energy risk professionals (ERP) exam from the Global Association of Risk Professionals (GARP). This course is a self-contained course which will help motivated, hard-working students develop themselves into a financial risk manager, an asset optimizer, a trader, a structuring and pricing analyst, a middle office analyst, a quantitative analyst, a data scientist, a quantitative programmer, etc."

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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

Lecture: 3 Lab: 0 Credits: 3

MSF 576**OOB 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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 505 with min. grade of C and MSF 504 with min. grade of C

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 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

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 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

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**Introduction to Public Administration**

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**Organizational Behavior**

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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

PA 515**Fundamentals of Innovative Business**

This course teaches the fundamentals of doing business in technology-intensive industries. Students will not only be exposed to the basics of starting, growing and running a profitable business, but also learn how to compete in industries wherein technological transformation is rapid and business innovation is the basis for competitive advantage. They will learn how companies create and capture value, and how to analyze the business environment, industry, competitors and customers. They will learn about the five major functions of technology companies – R&D, Marketing, Production, Accounting and Finance – and how they can be integrated to generate value for customers and companies. They will learn Strategy – both the conventional approach and the new blue ocean strategy approach. Finally, they will be able to understand the role of business ethics and data-driven approaches to decision-making in business innovation and sustainability.

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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

PA 517**Math with Financial Applications**

This is a graduate level course which describes various topics in Finance and The Financial Markets through Mathematics. The purpose of the course is to be informative (increase knowledge), developed analytical skills (thinking), and to be career enhancing (get a job and make money and add value to an institution and the World). Students will be held to a high level effort and responsibility. The major topics which will be covered are: 1. Simple, Compound, and Continuous Compound Interest 2. Annuities and Mortgages 3. Bond Pricing 4. Forward Contract 5. Option valuation at Expiration and Strategies 6. Duration and Convexity of Bonds 7. The Calculus of Options and the Black Scholes Merton Formula 8. Newton's Method for Solving Equations of Value 9. Volatility 10. Technical Analysis 11. Risk and Reward in a Portfolio 12. The Binomial Model for Option Pricing.

Lecture: 3 Lab: 0 Credits: 3

PA 518**Statistics for Managers**

This course covers statistics tools that are critical for managers in enabling their firms to have a competitive advantage. The course includes descriptive statistics, probability, sampling, estimation, hypothesis testing, linear regression, ANOVA, time-series and goodness-of-fit tests. The models address problems in a variety of business functional areas and business processes. 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

PA 520**Analytics for Decision Making**

After completing this course, students will know how to apply the built-in functionality of Microsoft Office Excel 2016 to analyze data, build Operations, Finance and Marketing-related spreadsheet models, formulate optimization models, and perform risk analysis using Monte Carlo simulation. These objectives will be facilitated through the following key tools taught in this course, which are: 1) Advanced Excel functionality; 2) Data Analysis; 3) Spreadsheet modeling; 4) Optimization (resource allocation); and 5) Simulation for risk-analysis and modeling uncertainty.

Lecture: 3 Lab: 0 Credits: 3

PA 521**Statistical Analysis in Financial Markets**

This course teaches statistics and econometric techniques useful for the analysis of business and financial data. It emphasizes fundamentals of business statistics and practical quantitative methods. Data collection, sampling, statistics description, probability models, regression models, and time series analysis are covered. Course project asks you to analyze a financial market issue using real-world data. Pre-requisites: Excel.

Lecture: 3 Lab: 0 Credits: 3

PA 522**Human Resource Management**

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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

PA 525**Marketing Strategy**

In this course we will emphasize Market Segmentation, the choice of 'Target Markets'; and the design and integration of the variables in the 'Marketing Mix' to create a 'Positioning'; and how these choices 'fit' with each other, the marketing strategy, other functional decisions and the competitive strategy of the Firm/SBU. The course will emphasize how understanding the segmentation of the market and the needs/behaviors of the Customer leads to 'Positioning' the integrated marketing mix to meet those needs over the product life cycle. This is often referred to as the S-T-P model. In addition to the development of a (set of) marketing strategy (ies) that 'positions' the product/service to the needs of one or more target markets (segmentation); the 'execution' of a marketing strategy (often referred to as 'Strategic Marketing Management') will require an economic and financial analysis of the costs and potential profits of the strategy to both the Vendor and the Customer; and an implementation plan including an organizational structure and an Expense Budget. This, combined with the S-T-P Marketing Strategy model; usually becomes the MARKETING PLAN and we will use the GOST (or similar) model to help organize and focus our ideas. Obviously, this will often be an iterative process to find an optimal combination of costs and pricing and volume to maximize profits.

Lecture: 3 Lab: 0 Credits: 3

PA 526**Qualitative and Survey Research Methods**

This course covers a range of qualitative research methods, including in-depth interviews, focus groups, ethnography, digital research, and surveys. Methods for both manual and automated research analysis are explored. The class will be exposed to a range of research applications across marketing, product development, and strategy.

Lecture: 3 Lab: 0 Credits: 3

PA 532**Public Financial Management**

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* with min. grade of C, 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* with min. grade of C, 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.

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* with min. grade of C, 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 it 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

Lecture: 3 Lab: 0 Credits: 3

PA 539**Local Government Management**

Students in this class will acquire the fundamental knowledge to manage functions in local government in such a way as to maximize limited resources for the effective and efficient delivery of public goods and services. Staying true to preserving the public trust and protecting the public interest students will learn what is required to lead a local government agency, department, and or unit of government. The student will gain and demonstrate knowledge regarding:

- The evolution of professional government management.
- The importance of achieving effective community leadership.
- Through critical thinking exercises, identify ways in which to enhance a governing body's effectiveness.
- How effective personnel management is critical to the success of the organization.
- The processes associated with policy implementation, performance measurements, and program evaluation.
- The need for effective intergovernmental relations.
- Why a professional code of ethics is critical to successful local government management.

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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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? .

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* with min. grade of C, 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* with min. grade of C, 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* with min. grade of C, 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 with min. grade of C

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* with min. grade of C, 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 with min. grade of C

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**Practicum**

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* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.

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 value 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

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 with min. grade of C

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 with min. grade of C

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.

Master of Business Administration Curriculum

Code	Title	Credit Hours
Core Courses		(33)
BUS 510	Fundamentals of Innovative Bus	3
BUS 550	Business Statistics	3
BUS 590	Business Strategy Capstone Pro	3
MBA 501	Financial Statement Applicatio	3
MBA 502	International Trade	3
MBA 504	Analytics for Decision Making	3
MBA 505	Microeconomics and Game Theory	3
MBA 506	Leadership and Organization De	3
MBA 509	Financial Management	3
MBA 511	Marketing Strategy	3
MBA 513	Operations & Tech Management	3
Elective Courses		(15)
Select 15 credit hours		15
Total Credit Hours		48

Concentrations

A concentration consists of a minimum of six credit hours in one of the following areas. Details on course requirements are available in the M.B.A. Specializations section (p. 518).

- Business Analytics
- Business and Society
- Corporate Finance
- Creativity and Innovation
- Emerging Markets
- Investment Management
- Management of Nonprofits
- Management of Public Sector
- Risk Management
- Strategy and Leadership
- Sustainability
- Technology and Marketing
- Technopreneurship

Accelerated Master of Business Administration Curriculum

Code	Title	Credit Hours
Foundational Courses		(6) ¹
BUS 510	Fundamentals of Innovative Bus	3
MBA 501	Financial Statement Applicatio	3
Core Courses		(24)
BUS 550	Business Statistics	3
BUS 590	Business Strategy Capstone Pro	3
MBA 504	Analytics for Decision Making	3
MBA 505	Microeconomics and Game Theory	3
MBA 506	Leadership and Organization De	3
MBA 509	Financial Management	3
MBA 511	Marketing Strategy	3
MBA 513	Operations & Tech Management	3
Elective Courses		(6)
Select a minimum of six credit hours from the following: ²		6
MBA 502	International Trade	3
MBA 523	Negotiations & Strat Dec Mkng	3
MBA 524	Human Capital Management	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.

Specialization Courses

13 M.B.A. specializations are available. To earn a specialization, the student must complete 6-12 credit hours within an identified focus area.

Business Analytics

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
MAX 521	Qualitative Research Methods	3
MAX 522	Predictive Analytics	3
MAX 523	Social Media Mktg Analytics	3
SMGT 525	Envtl Performance Analytics	3
Total Credit Hours		6

Business and Society

Code	Title	Credit Hours
MBA 518	Ethics Corp Soc Responsibility	3
MBA 529	Social Entrepreneurship	3
Total Credit Hours		6

Corporate Finance

Code	Title	Credit Hours
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/OTC Derivatives	3
MSF 534	Corporate Finance	3
MSF 535	Investment Banking	3
Total Credit Hours		12

Creativity and Innovation

Code	Title	Credit Hours
MBA 528	Management of Innovation and T	3
MBA 577	Got Creativity?	3
Total Credit Hours		6

Emerging Markets

Code	Title	Credit Hours
MBA 564	Global Business Strategy	3
MBA 569	Asian & Western Enterprises	3
Total Credit Hours		6

Investment Management

Code	Title	Credit Hours
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/OTC Derivatives	3
MSF 545	Struct Fixed Income Portfolios	3
MSF 546	Quant Investment Strategies	3
Total Credit Hours		12

Management of Non-Profits

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
MBA 587	Nonprof and the Public Sector	3
MBA 588	The Nonprofit Sector	3
MBA 589	Regl Politics & Contemp Bus	3
Total Credit Hours		6

Management of Public Sector

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
PA 501	Introduction to Public Admin	3
PA 522	Human Resource Management	3
PA 570	Social Capital & the Community	3
PA 588	Incident Rspnse Disaster Rcvry	3
Total Credit Hours		6

Risk Management

Code	Title	Credit Hours
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/OTC Derivatives	3
MSF 554	Market Risk Management	3
MSF 555	Credit Risk Management	3
Total Credit Hours		12

Strategy and Leadership

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
MBA 522	The General Manager	3
MBA 523	Negotiations & Strat Dec Mkng	3
MBA 524	Human Capital Management	3

MBA 586	Strategic Marketing Management	3
Total Credit Hours		6

Sustainability

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
MAX 513	Managing Sustainable Brands	3
MBA 526	Supply Chain Management	3
SMGT 504	Ind Ecology & Systems Thinking	3
Total Credit Hours		6

Technology and Marketing

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
MAX 511	Integrated Mktg Comm Strategy	3
MAX 512	Customer Touch Points	3
MAX 516	Social Media Mktg Strategy	3
Total Credit Hours		6

Technopreneurship

Code	Title	Credit Hours
Select a minimum of six credit hours from the following:		6
MBA 554	Project Management	3
MBA 575	Creativity/Contemp Enterp Opps	3
MBA 576	New Technology Ventures	3
Total Credit Hours		6

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 or MSF 524	Futures/Option/OTC Derivatives Models for Derivatives	3
MSF 526	Computational Finance	3
MATH 542	Stochastic Processes	3
MATH 548	Mathematical Finance I	3
MATH 565	Monte Carlo Methods in Fin	3
MATH 582	Mathematical Finance II	3
MATH 586	Ther&Prac Fixed Income Modelng	3
MATH 588	Advanced Quant Risk Mgmt	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 527	Machine Learning in Finance:	3
MATH 540	Probability	3
MATH 543	Stochastic Analysis	3
MATH 544	Stochastic Dynamics	3
MATH 545	Stochastic Partial Diff Equatn	3
MATH 546	Introduction to Time Series	3
MATH 566	Multivariate Analysis	3
MATH 567	Adv 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 Prob	3
MATH 587	Thry/Prac Modlng&Crdt Deritvs	3
MATH 589	Num Meth for Partial Diff Equa	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 Struc Mod & Int Rate Der	3
MSF 545	Struct Fixed Income Portfolios	3
MSF 546	Quant 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 575	C++ with Financial Markets	3
MSF 576	OOP & Algorithmic Trading Sys	3
MSF 577	High Frequency Finance	3
MSF 584	Equity & Equity Deriv Trading	3
MSF 585	FOREX & Fixed Income Strat	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 eight core courses.

Code	Title	Credit Hours
Required Courses		(24)
PA 501	Introduction to Public Admin	3
PA 502	Organizational Behavior	3
PA 522	Human Resource Management	3
PA 532	Public Financial Management	3
PA 568	Strat Comp in the Public Sect	3
PA 580	Policy Evaluation Analytics	3
PA 581	Policy Design Analytics	3
PA 599	Practicum	3
Elective Courses		(9)
Select nine credit hours. Students may select courses to fulfill a desired specialization. See Specializations tab on this page for more details.		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 six credit hours may be taken in university courses numbered between 400 and 499. A maximum of nine 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.

Code	Title	Credit Hours
Required Courses		(9)
Select a minimum of nine credit hours from the following:		9
PA 505	The Law & the Nonprofit Sector	3
PA 533	Adv Financial Management	3
PA 535	Resource Dev in the Nonprofit	3
PA 540	Alternative Dispute Resolution	3
PA 541	Perf Meas Nonprofit/Pub Mgmt	3
PA 543	Public Pol/Nonprofits/Phlnthrp	3
PA 565	The Nonprofit Sector	3
PA 566	Nonprofits and the Public Sctr	3
PA 570	Social Capital & the Community	3
PA 579	Ethics & Prof Responsibility	3
Total Credit Hours		9

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.

Code	Title	Credit Hours
Required Courses		(9)
Select a minimum of nine credit hours from the following:		9
PA 503	Administration Law	3
PA 536	Strategy & Structure: Homeland	3
PA 537	Crisis Mgmt/Homeland Security	3
PA 538	Info Syst Security/Cyber Crime	3
PA 539	Local Government Mgmt	3
PA 540	Alternative Dispute Resolution	3
PA 541	Perf Meas Nonprofit/Pub Mgmt	3
PA 553	Public Safety Administration	3
PA 556	Public Mgmt Strat 21st Century	3
PA 579	Ethics & Prof Responsibility	3
PA 588	Incident Rspnse Disaster Rcvry	3
Total Credit Hours		9

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.

Code	Title	Credit Hours
Required Courses		(9)
Select a minimum of nine credit hours from the following:		9
PA 533	Adv Financial Management	3
PA 539	Local Government Mgmt	3
PA 550	Social Entrepreneurship	3
PA 551	Public Infrastructure Mgmt	3
PA 555	Intro to Urban & Regional Plan	3
PA 556	Public Mgmt Strat 21st Century	3
PA 557	Urban and Regional Dev	3
PA 560	Political Economy	3
PA 570	Social Capital & the Community	3
PA 578	Plan,Policy Making&Bult Envir	3
PA 579	Ethics & Prof Responsibility	3
Total Credit Hours		9

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 18-21 credit hours of core courses and 9-12 credit hours of elective courses.

Code	Title	Credit Hours
Core Courses		(18-21)
Select 18-21 credits from the following:		18-21
BUS 510	Strategy & Innovation	3
BUS 590	Business Strategy Capstone Pro	9-12
IDX 560	Intro to Design Thinking	3
MBA 576	New Technology Ventures	3
Elective Courses		(9-12)
Select 9-12 credits from the following:		9-12
IDX 562	Multidisciplinary Prototyping	3
LAW 171	Entrepreneurship Law	3
LAW 319	Bus. Entity Formation & Trans.	3
LAW 248	Emerging Technologies	2
IPMM 501	Managing the Creative Process	3
IPMM 504	IP and Business Strategy	3
Select up to twelve credit hours ¹		
Total Credits Required		(30)
(minimum credit requirement)		30

¹ Up to 9 credits of undergraduate coursework are allowed as electives per the AMP rules. Other graduate courses can be used as electives with approval of the student's advisor and the MTE program director prior to registration.

Master of Science in Environmental Management and Sustainability

To earn an Master of Science in Environmental Management and Sustainability, 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 one and completing their program in summer of year two, but this requires careful planning.

Curriculum

Code	Title	Credit Hours
Core Courses		(33)
BUS 550	Business Statistics	3
EMS 502	Environmental Law	3
EMS 503	Environmental Pollution Ctrl	3
EMS 504	Industrial Ecology	3
EMS 505	Envtl Economics & Finance	3
EMS 512	Environmental Risk Assessment	3
EMS 541	Sustainable Energy Systems	3
EMS 543	Envtl Compliance & Regulation	3
Select a minimum of nine credit hours from the following:		9
BUS 590	Business Strategy Capstone Pro	3
EMS 501	Environmental Policy	3
EMS 511	Solid & Hazardous Waste Mgmt	3
EMS 529	Social Entrepreneurship	3

EMS 532	Envtl and Energy Law Clinic	3
EMS 542	Economics of Energy Systems	3
EMS 595	Special Topics in EMS	3
Total Credit Hours		33

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 courses 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.

Code	Title	Credit Hours
Core Courses		(18)
MSF 501	Math with Financial Appls.	3
MSF 502	Statistical Analys in Fin Mkts	3
MSF 503	Financial Modeling	3
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/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 & Managed Futures	3
Corporate Finance		
MSF 534	Corporate Finance	3
MSF 535	Investment Banking	3
Entrepreneurial Finance		
MSF 595	Entrepreneurial Finance	3
MSF 596	The Venture Capital Process	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 Struc Mod & Int Rate Der	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 & Algorithmic Trading Sys	3
MSF 577	High Frequency Finance	3
Investment Management		
MSF 544	Equity Valuation	3
MSF 545	Struct Fixed Income Portfolios	3
MSF 546	Quant 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 & Equity Deriv Trading	3
MSF 585	FOREX & Fixed Income Strat	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).

Code	Title	Credit Hours
Core Courses		(12)
MSC 511	Math for Mgmt Science I	3
MSC 512	Statistics for Mgmt Science I	3
MSC 514	Math for Mgmt Science II	3
MSC 515	Statistics for Mgmt Science II	3
Specialization Courses		(12)
Select twelve credit hours (see Specializations tab for required courses)		12
Elective Courses		(9)
Select a minimum of nine credit hours from any 500-level BUS, EMS, MAX, MBA, MSC, MSF, or PA courses. ¹		9
Total Credit Hours		33

¹ Registration in these courses requires prior approval of program director.

Management Science Specializations

Analytics

Code	Title	Credit Hours
Required Courses		(12)
MAX 502	Analytics for Decision Making	3
MAX 503	Marketing Research & Engg	3
MAX 522/MSC 615	Predictive Analytics	3
MAX 523/MSC 616	Social Media Mktg Analytics	3
Total Credit Hours		12

Quantitative Finance

Code	Title	Credit Hours
Required Courses		(12)
MSC 631	Theory of Finance I	3
MSC 633	Theory of Finance II	3
MSF 545/MSC 613	Struct Fixed Income Portfolios	3
MSF 546/MSC 614	Quant Investment Strategies	3
Total Credit Hours		12

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 one and completing their program in summer year two, but this requires careful planning.

Curriculum

Code	Title	Credit Hours
Core Courses		(33)
BUS 510	Fundamentals of Innovative Bus	3
BUS 550	Business Statistics	3
BUS 590	Business Strategy Capstone Pro	3
MAX 501	Digital Marketing	3
MAX 502	Analytics for Decision Making	3
MAX 503	Marketing Research & Engg	3
MAX 504	Marketing Strategy	3
MAX 505	Strategic Marketing Management	3
Select nine credit hours in Marketing Analytics electives:		9
MAX 521	Qualitative Research Methods	3
MAX 522	Predictive Analytics	3
MAX 523	Social Media Mktg Analytics	3
MAX 526	Quantitative Marketing Models	3
MAX 595	Special Topics	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). Other requirements include an essay outlining the fit between the applicant's background, expertise, and career goals, and letters of recommendation. Journal publications or conference presentation activities of Ph.D. applicants that attest to their research experience and future research potential are preferred, although not essential.

The following are additional requirements for each of the four tracks within the Ph.D. in Management Science:

1. M-track with Analytics concentration: a graduate degree considered equivalent to the M.S. in Marketing Analytics degree offered at the Stuart School
2. M-track with Quantitative Finance concentration: a graduate degree considered equivalent to the M.S. in Finance degree offered at the Stuart School
3. UG-track with Analytics or Quantitative Finance 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 quantitative 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 quantitative 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.

Quantitative Finance Concentration

Graduates of the Ph.D. program with a concentration in Quantitative 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.

Code	Title	Credit Hours
Basic Core Requirements		(12)
MSC 511	Math for Mgmt Science I	3
MSC 512	Statistics for Mgmt Science I	3
MSC 514	Math for Mgmt Science II	3
MSC 515	Statistics for Mgmt Science II	3
HUM 601	TA Seminar	0
Advanced Core Requirements		(24)
MSC 611	Philosophy of Management	3
MSC 612	Advanced Research Methods	3
Specialization courses (see Specializations tab for required courses)		18
Ph.D. Research		(24)
MSC 691	Research and Thesis PhD	24
Total Credit Hours		60

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.

Code	Title	Credit Hours
Basic Core Requirements		(12)
MSC 511	Math for Mgmt Science I	3
MSC 512	Statistics for Mgmt Science I	3
MSC 514	Math for Mgmt Science II	3
MSC 515	Statistics for Mgmt Science II	3
HUM 601	TA Seminar	0
Advanced Core Requirements		(24)
MSC 611	Philosophy of Management	3
MSC 612	Advanced Research Methods	3
Specialization courses (see Specializations tab for required courses)		18
Ph.D. Research		(24)
MSC 691	Research and Thesis PhD	24
Elective Courses		(18)
Select a minimum of 18 credit hours from any 500-level BUS, EMS, MAX, MBA, MSC, MSF, or PA courses. ¹		18
Total Credit Hours		78

¹ Registration in these courses requires prior approval of program director.

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 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.

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.

Management Science Specializations

Analytics

Code	Title	Credit Hours
Required Courses		(18)
MAX 522/MSC 615	Predictive Analytics	3
MAX 523/MSC 616	Social Media Mktg Analytics	3
MSC 651	Quantitative Marketing Models	3
MSC 652	Supply Chain Analytics	3
MSC 653	Topics in Marketing Analytics	3
MSC 654	Social Network Analytics	3
Total Credit Hours		18

Quantitative Finance

Code	Title	Credit Hours
Required Courses		(18)
MSC 621	Corporate Finance	3
MSC 623	Investments	3
MSC 631	Theory of Finance I	3
MSC 633	Theory of Finance II	3
MSF 545/MSC 613	Struct Fixed Income Portfolios	3
MSF 546/MSC 614	Quant Investment Strategies	3
Total Credit Hours		18

Certificate in Compliance and Pollution Prevention Curriculum

Code	Title	Credit Hours
Required Courses		(9)
EMS 502	Environmental Law	3
EMS 503	Environmental Pollution Ctrl	3
Select one of the following courses:		3
EMS 511	Solid & Hazardous Waste Mgmt	3
EMS 512	Environmental Risk Assessment	3
EMS 513	Envtl Economics/Climate Change	3
EMS 543	Envtl Compliance & Regulation	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Compliance and Pollution Prevention

Certificate in Corporate Finance (Post-Graduate) Curriculum

Code	Title	Credit Hours
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

Gainful Employment Disclosure for Certificate in Corporate Finance

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.

Gainful Employment Disclosure for Certificate in Economic Development and Social Entrepreneurship

Curriculum

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
PA 533	Adv Financial Management	3
PA 539	Local Government Mgmt	3
PA 550	Social Entrepreneurship	3
PA 551	Public Infrastructure Mgmt	3
PA 555	Intro to Urban & Regional Plan	3
PA 556	Public Mgmt Strat 21st Century	3
PA 557	Urban and Regional Dev	3
PA 560	Political Economy	3
PA 570	Social Capital & the Community	3
PA 578	Plan,Policy Making&Bult Envir	3

PA 579	Ethics & Prof Responsibility	3
Total Credit Hours		12

Additional courses could be taken in the Stuart environmental management and sustainability program, the Department of Civil, Architectural, and Environmental Engineering, and other related programs as permitted by program director.

Certificate in Financial Economics (Post-Graduate)

Curriculum

Code	Title	Credit Hours
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

Gainful Employment Disclosure for Certificate in Financial Economics

Certificate in Financial Modeling (Post-Graduate)

Curriculum

Code	Title	Credit Hours
Select a minimum of three courses from the following:		9
MSF 524	Models for Derivatives	3
MSF 525	Term Struc Mod & Int Rate Der	3
MSF 575	C++ with Financial Markets	3
MSF 576	OOP & Algorithmic Trading Sys	3
MSF 577	High Frequency Finance	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Financial Modeling

Certificate in Financial Toolbox

Curriculum

Code	Title	Credit Hours
Required Courses		(9)
MSF 501	Math with Financial Appls.	3
MSF 502	Statistical Analys in Fin Mkts	3
MSF 503	Financial Modeling	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Financial Toolbox

Certificate in Fundamentals of Finance

Curriculum

Code	Title	Credit Hours
Required Courses		(9)
MSF 504	Valuation/Portfolio Management	3
MSF 505	Futures/Option/OTC Derivatives	3

MSF 506	Financial Statement Analysis	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Fundamentals of Finance

Certificate in Investments (Post-Graduate)

Curriculum

Code	Title	Credit Hours
Select a minimum of three courses from the following:		9
MSF 545	Struct Fixed Income Portfolios	3
MSF 546	Quant Investment Strategies	3
MSF 549	Commodities & Managed Futures	3
Total Credit Hours		9

Gainful Employment Disclosure for Certificate in Investments

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.

Gainful Employment Disclosure for Certificate in Nonprofit and Mission-Driven Management

Curriculum

Code	Title	Credit Hours
Core Course		(12)
PA 502	Organizational Behavior	3
Select a minimum of three core courses from the following:		9
PA 505	The Law & the Nonprofit Sector	3
PA 533	Adv Financial Management	3
PA 540	Alternative Dispute Resolution	3
PA 541	Perf Meas Nonprofit/Pub Mgmt	3
PA 543	Public Pol/Nonprofits/Phlnthrp	3
PA 556	Public Mgmt Strat 21st Century	3
PA 565	The Nonprofit Sector	3
PA 566	Nonprofits and the Public Sctr	3
PA 570	Social Capital & the Community	3
PA 579	Ethics & Prof Responsibility	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.

Gainful Employment Disclosure for Certificate in Public Management

Curriculum

Code	Title	Credit Hours
Core Courses		(12)
Select a minimum of one course from the following:		3
PA 501	Introduction to Public Admin	3
PA 502	Organizational Behavior	3
PA 532	Public Financial Management	3
Select a minimum of three courses from the following:		9
PA 511	Comparative Public Admin	3
PA 516	Info Tech in Public Admin	3
PA 522	Human Resource Management	3
PA 533	Adv Financial Management	3
PA 539	Local Government Mgmt	3
PA 540	Alternative Dispute Resolution	3
PA 541	Perf Meas Nonprofit/Pub Mgmt	3
PA 551	Public Infrastructure Mgmt	3
PA 556	Public Mgmt Strat 21st Century	3
PA 562	Urban and Metropolitan Gov	3
PA 568	Strat Comp in the Public Sect	3
PA 578	Plan,Policy Making&Bult Envir	3
PA 579	Ethics & Prof Responsibility	3
PA 580	Policy Evaluation Analytics	3
Total Credit Hours		12

Certificate in Risk Management (Post-Graduate)

Curriculum

Code	Title	Credit Hours
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

Gainful Employment Disclosure for Certificate in Risk Management

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.

Gainful Employment Disclosure for Certificate in Security, Safety, and Risk Management

Curriculum

Code	Title	Credit Hours
Select a minimum of four courses from the following:		12
PA 503	Administration Law	3
PA 536	Strategy & Structure: Homeland	3
PA 537	Crisis Mgmt/Homeland Security	3

PA 538	Info Syst Security/Cyber Crime	3
PA 539	Local Government Mgmt	3
PA 540	Alternative Dispute Resolution	3
PA 541	Perf Meas Nonprofit/Pub Mgmt	3
PA 553	Public Safety Administration	3
PA 556	Public Mgmt Strat 21st Century	3
PA 579	Ethics & Prof Responsibility	3
PA 588	Incident Rspnse Disaster Rcvry	3

Total Credit Hours

12

Certificate in Sustainable Enterprise

Curriculum

Code	Title	Credit Hours
Required Course		(9)
BUS 510	Fundamentals of Innovative Bus	3
EMS 504	Industrial Ecology	3
EMS 529	Social Entrepreneurship	3

Total Credit Hours

9

Gainful Employment Disclosure for Certificate in Sustainable Enterprise

Certificate in Trading (Post-Graduate)

Curriculum

Code	Title	Credit Hours
Select a minimum of three courses from the following:		9
MSF 576	OOP & Algorithmic Trading Sys	3
MSF 577	High Frequency Finance	3
MSF 584	Equity & Equity Deriv Trading	3
MSF 585	FOREX & Fixed Income Strat	3

Total Credit Hours

9

Gainful Employment Disclosure for Certificate in Trading

Interdisciplinary Education

Energy/Environment/Economics (E3)

Faculty Directors

Chemical and Environmental Engineering

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 Perlstein Hall, Room 127
 10 W. 33rd St.
 Chicago, IL 60616
 312.567.3047
 abbasian@iit.edu

Mechanical, Materials, and Aerospace Engineering

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 John T. Rettaliata Engineering Center, Room 252-D
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Electrical and Computer 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 (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.

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 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 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. 60)
- Electrical and Computer Engineering (p. 122)
- Mechanical, Materials, and Aerospace Engineering (p. 188)

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 E³ specialization courses. The following

section details the E³ course requirements for the professional master's, M.S., and Ph.D. degrees in chemical engineering, environmental engineering, mechanical and aerospace engineering, and electrical engineering. 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 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 the 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. 60)
- Electrical and Computer Engineering (p. 122)
- Mechanical, Materials, and Aerospace Engineering (p. 188)

Degrees Offered

Professional Master's/Master of Engineering

- Master of Chemical Engineering with E3 Specialization (p. 539)
- Master of Electrical and Computer Engineering with E3 Specialization (p. 539)
- Master of Engineering in Environmental Engineering with E3 Specialization (p. 540)
- Master of Engineering in Materials Science and Engineering with E3 Specialization (p. 541)
- Master of Engineering in Mechanical and Aerospace Engineering with E3 Specialization (p. 542)

Master of Science

- Master of Science in Chemical Engineering with E3 Specialization (p. 542)
- Master of Science in Electrical Engineering with E3 Specialization (p. 543)
- Master of Science in Environmental Engineering with E3 Specialization (p. 545)
- Master of Science in Materials Science and Engineering with E3 Specialization (p. 546)
- Master of Science in Mechanical and Aerospace Engineering with E3 Specialization (p. 547)

Doctor of Philosophy

- Doctor of Philosophy in Chemical Engineering with E3 Specialization (p. 549)
- Doctor of Philosophy in Electrical Engineering with E3 Specialization (p. 549)
- Doctor of Philosophy in Environmental Engineering with E3 Specialization (p. 550)

E3 Courses

See descriptions under the respective department's course listings.

Group A

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	Artificial Intelligence in Smart Grid	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	Conduction and Diffusion	3
MMAE 527	Heat Transfer: Convection and Radiation	3

Group B

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 six to eight credit hours of M.S. thesis research, students are required to register for two to five 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	Applctn Math Cheml Engrg	3
CHE 551	Advanced Tnsport Phenomena	3
CHE 553	Advanced Thermodynamics	3
Special Projects Research		(2-5)
CHE 594	Special Projects	2-5
E3 Courses		(9)
CHE 543	Energy Envir 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 five to eight credit hours		5-8
Recommended		(1)
CHE 593	Seminar in Chemical Engrng (or general seminars offered 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 Envir 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	Hybrid Electric Vehicle Drives	4
ECE 417	Power Dist Engring	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3

ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 506	Anlys Nonlinear Systems	3
ECE 531	Linear System Theory	3
ECE 535	Discrete Time Systems	3
ECE 538	Renewable Energies	3
ECE 539	Cmpt Aided Dsgn Elec Machines	3
ECE 540	Relibilty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 564	Cntrl Oprtn Elect Power Sys	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 three to six 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 Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	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 three to six 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 CAE 589 as a Group B course option.

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 Envir Economics	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	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	Renwble Enrgy Technologies	3
CHE 566	Electrochemical Engineering	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
Non-Core Courses		(9)
Select a minimum of two courses from the following:		6
MMAE 470	Intro to Polymer Science	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 566	Prlms High Temp Materials	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	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Electives		(6)
Select a minimum of six credit 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 Envir 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	Renwble Enrgy Technologies	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals 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	Conduction and Diffusion	3
MMAE 527	Heat Trnsf Convection Radiatio	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Enrgy Technologies	3
CHE 560	Ststcl Qlty Process Control	3
or MMAE 560	Ststcl Quality Procs Control	
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Electives		(6)
Select six 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 six to eight 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	Applctn Math Cheml Engrg ¹	3
CHE 551	Advanced Tnsport Phenomena ¹	3
CHE 553	Advanced Thermodynamics ¹	3
E3 Courses		(9)
CHE 543	Energy Envir 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 M.S.	6-8
Electives		(2-4)
Select two to four credit hours		2-4
Recommended		(1)
CHE 593	Seminar in Chemical Engrng (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 Envir 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	Hybrid Electric Vehicle Drives	4
ECE 417	Power Dist Engring	3
ECE 419	Power Systems Analysis w/Lab	4
ECE 420	Analyt. Methods for Power Syst	3
ECE 438	Control Systems	3
ECE 505	Applied Optimization Engrgs	3
ECE 506	Anlys 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	Cmpt Aided Dsgn Elec Machines	3
ECE 540	Relibilty Theory Syst Implntn	3
ECE 548	Energy Harvesting	3
ECE 549	Motion Control Syst Dynamics	3
ECE 550	Power Elect Dynmcs Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power Systems Relaying	3
ECE 555	Power Market Operations	3
ECE 556	Power Mkt Ecnmcs Security	3
ECE 557	Fault Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Trans	3
ECE 560	Power Syst Dynamics Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power Syst Tran Management	3
ECE 563	Comptl Intlgnce Engineering	3
ECE 564	Cntrl Oprtn Elect Power Systs	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 & Data Comm Systems	3
ECE 405	Digital & Data Comm Syst w/Lab	4
ECE 421	Microwave Circuits and Systems	3
ECE 423	Microwave Crct&Systs w/Lab	4
ECE 436	Digital Signal Pcsgr w/Lab	4
ECE 437	Digital Signal Processing I	3
ECE 481	Image Processing	3
ECE 504	Wireless Comm Systm Design	3
ECE 507	Imaging Theory & Applications	3
ECE 508	Video Processing & Comm	3
ECE 509	Electromagnetic Field Theory	3
ECE 511	Analysis Random Signals	3
ECE 513	Commctn Engrg Fundamentals	3
ECE 514	Digital Commctn Principles	3
ECE 515	Modern Digital Communications	3
ECE 516	Coding Distributed Storage Sys	3
ECE 519	Coding Reliable Communications	3
ECE 522	Electromagnetic Compatibility	3
ECE 565	Compt Vision Image Processing	3
ECE 566	Statistical Pattern Rcgntn	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 Syst	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	Intro Comp Ntwks with Lab	4
ECE 408	Intro to Computer Ntwks	3
ECE 425	Anlys Dsgn Intgrtd Circuits	3
ECE 429	Intro to VLSI Design	4
ECE 441	Microcomputers/Embedded Comp	4
ECE 443	Intro Computer Cyber Security	4
ECE 446	Advanced Logic Design	4
ECE 449	Obj-Orntd Cmptr Sim	3
ECE 485	Computer Organization & Design	3
ECE 502	Basic Network Theory	3
ECE 521	Quantum Electronics	3
ECE 524	Adv Electronic Circuit Design	3
ECE 525	RF Integrated Circuit Design	3
ECE 526	Active Filter Design	3
ECE 527	Perform Anlys RF Intgrtd Crcts	3
ECE 529	Advncd VLSI Systems Dsgn	3
ECE 530	High Performnc VLSI/IC Systems	3
ECE 541	Perform Eval Compt Ntwrk	3
ECE 542	Dsgn Optmztn Compt Ntwrks	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 Ntwrks Perf Analysis	3
ECE 571	Nanodevices Technology	3
ECE 575	Electron Devices	3
ECE 583	High Speed Compt Arithmetic	3
ECE 584	VLSI Archs Sgnl Prcs Commcncts	3
ECE 585	Advanced Compt Arch	3
ECE 586	Fault Dctcntn Digital Circuits	3
ECE 587	Hardware Software Codesign	3
ECE 588	CAD Techniques VLSI Dsgn	3
ECE 589	CAD of Analog IC	3

Master's Thesis Research**(6-8)**

ECE 591	Research and Thesis M.S. ¹	6-8
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General Electives**(0-2)**

Select zero to two credit hours of ECE 400-599, ECE 600-699, and ECE 700-799 ²		0-2
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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 Engg Data	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	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 zero to two 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 CAE 589 as a Group B course option.

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 Envir Economics	3
MMAE 554	Elec,Mag, Optical Prop of Mtrl	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	Renwble Enrgy Technologies	3
CHE 566	Electrochemical Engineering	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
Non-Core Courses		(9)
Select a minimum of two courses from the following:		6
MMAE 470	Intro to Polymer Science	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 561	Solidification & Crystal Grwth	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 566	Prlms High Tempte Materials	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	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3
Thesis Research		(6-8)

MMAE 591	Research and Thesis M.S.	6-8
Electives		(0-2)
Select zero to two credit hours		0-2

Minimum degree credits required: 32

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3)

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (Coursework Only Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Engineering Analysis Courses		(3)
MMAE 501	Engineering Analysis I	3
Core Courses		(12)
CHE 543	Energy Envir Economics	3
Select a minimum of three credit hours from the following:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	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
MMAE 525	Fundamentals of Heat Transfer	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Enrgy Technologies	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
MMAE 524	Fundamentals of Combustion	3
Non-Core Courses		(6)
Select a minimum of one course from the following:		3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Conduction and Diffusion	3
MMAE 527	Heat Trnsf Convection Radiatio	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Enrgy Technologies	3
CHE/MMAE 560	Ststcl Qlty Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3

ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Clng	3
ENVE 580	Hazardous Waste Engineering	3

Elective Courses (11)

Select a minimum of 11 credit hours of 400-level and above MMAE courses ¹ 11

¹ Students may include up to six credit hours of MMAE 594 Project for Master of Engineering Students.

Master of Science in Mechanical and Aerospace Engineering with Specialization in Energy/Environment/Economics (E3) (Thesis Option)

Requirement	Credits
Minimum Credits Required	32
Maximum 400-Level Credit	9
Maximum 700-Level Credit	6

Code	Title	Credit Hours
Engineering Analysis Courses		(6)
MMAE 501	Engineering Analysis I	3
MMAE 502	Engineering Analysis II	3
Core Courses		(12)
CHE 543	Energy Envir Economics	3
Select a minimum of three credit hours from the following:		3
MMAE 451	Finite Elmnt Methods in Engrg	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 532	Finite Element Methods II	3
MMAE 544	Design Optimization	3
MMAE 570	Computational Methods in MSE	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
MMAE 525	Fundamentals of Heat Transfer	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Engrg Technologies	3
MMAE 522	Nuclear F-F & Sust Energy Sys	3
MMAE 523	Fundamentals Power Generation	3
MMAE 524	Fundamentals of Combustion	3
Non-Core Courses		(6)
Select a minimum of one course from the following:		3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Conduction and Diffusion	3
MMAE 527	Heat Trnsf Convection Radiatio	3
Select a minimum of one course from the following:		3
CHE 541	Renwble Engrg Technologies	3
CHE/MMAE 560	Ststcl Qlty Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physcheml Prcs in Envir Eng	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Dsgn of Envrmtl Engr Prcs	3
ENVE 570	Air Pollution Meteorology	3

ENVE 577	Dsgn of Air Poltn Control Dvcs	3
ENVE 578	Phys&Chem Prcs Indus Gas Cng	3
ENVE 580	Hazardous Waste Engineering	3
Thesis Research		(6-8)
MMAE 591	Research and Thesis M.S.	6-8

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

Curriculum

Students interested in the Ph.D. program in all disciplines (chemical; environmental; 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 E³ 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 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 E³ 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 Engg	
CHE 535	Applctn Math Cheml Engrg	3
CHE 551	Advanced Tnsport Phenomena	3
CHE 553	Advanced Thermodynamics	3
CHE 543	Energy Envir Economics	3
Select five 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 Envir Economics	3
Select a minimum of five courses from Groups A and B		15
Ph.D. Research		(24-36)
ECE 691	Research and Thesis 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 Envir Economics	3
Select five 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 CAE 589 as a Group B course option.

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. 554)

Course Descriptions

IPMM 405

Patent Analysis

Patent analysis is a relatively recent but rapidly expanding field. An analysis of a collection of technically similar patents is used to define, among other things: the patent landscape; white spaces for invention; the competitive environment for the subject technology; and the relationship of a patents portfolio to the actual business of an enterprise. This course will instruct students on how to conduct patent analysis that incorporates fundamental knowledge of patent law and patent drafting with subject matter expertise in a technology field.

Lecture: 3 Lab: 0 Credits: 3

IPMM 406

Introduction to Intellectual Property

This course will properly survey the ethical, legal, business, and technical aspects of intellectual property protection schemes.

Lecture: 3 Lab: 0 Credits: 3

IPMM 450

Introduction to Intellectual Property and the Manual of Patent Examining Procedure

The course will teach principles of intellectual property that affect the operations, planning, knowledge management, and new products/ processes development of businesses. The second half of the semester will be dedicated to an extensive analysis of the Manual of Patent Examining Procedure, preparing students to sit for and pass the "Patent Bar Examination".

Lecture: 3 Lab: 0 Credits: 3

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 IP 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

No thesis is required, but there is a capstone/project course requirement (two 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.

Code	Title	Credit Hours
Required Courses		(24)
IPMM 500	Context/Intro & Protecting IP	4
IPMM 501	Managing the Creative Process	3
IPMM 502	IAM Methodologies & IP Assess	3
IPMM 503	Acquiring IP	3
IPMM 504	IP and Business Strategy	3
IPMM 505	Global IP Management	3
IPMM 506	Maximizing IP Value	3
IPMM 507	Capstone	2
Elective Courses		(6)
Select six credit hours from any of the disciplines.		6
Total Credit Hours		30

ACADEMIC POLICIES AND PROCEDURES

Academic Advising

Advising PIN

Each academic unit is responsible for issuing the Advising PIN required for registration in the first semester of student enrollment at Illinois Tech. The academic unit's website will outline specific advising policies and the process a student will follow to obtain the Advising PIN.

Graduate Academic Advising Session (Mandatory)

Graduate students are required to complete a mandatory advising session with their graduate academic adviser. In order to ensure compliance, an advising hold is placed on the student's registration when a master's student has nine earned and/or enrolled credit hours, and when a doctoral student has 18 earned and/or enrolled credit hours. This GP (Graduate Program) Advising Hold prevents registration for the next term until the required advising meeting has occurred. After the advising meeting has been completed, the adviser will lift the registration hold.

Co-terminal students are required to meet with the academic adviser to plan co-terminal shared and non-shared graduate courses. A GC Graduate Co-terminal Hold is placed on the student's registration after the initial semester of co-terminal enrollment, which prevents future registration until the required eForm is submitted with the declaration of courses. After the eForm is fully approved by the adviser, academic unit, and Graduate Academic Affairs, the registration hold will be lifted.

For more information on advising, please refer to individual academic unit websites.

Graduate Degree Works

Graduate student progress toward degree requirements can be reviewed in Graduate Degree Works. To access Graduate Degree Works:

- Login to the **MyIIT portal** (my.iit.edu) with the assigned username and password
 - Students who require assistance accessing the **MyIIT portal** can send an email to support@iit.edu (OTS Support Services)
 - **Faculty** select the **Teaching tab**
 - **Students** select the **Academics tab**
 - **Staff** first configure the channel on the **Work tab**, then select it
 - Next, navigate to the **Graduate Academic Affairs Channel** and select **Graduate Degree Works** to open the **Worksheet** (default screen)
- Review the required and elective course requirements shown on the Worksheet
 - If the degree program includes research, review the research course and non-course requirements
 - Failed courses will appear in the Falthrough section of the Worksheet
 - All failed courses must be repeated to raise the program GPA, with a maximum course repeat limit of two courses allowed for grade point average recalculation (see the Repeating a Course section (p. 568))
 - Note restrictions on the use of certain courses and credits shown on the Worksheet (this appears as a remark at the top of the Major block on the Worksheet). Restrictions may include:
 - Transfer credit
 - Courses numbered 400 (upper-division undergraduate courses)
 - Repeatable courses numbered 595, 597, etc.
 - Accelerated course credits numbered 700
- The student should review the **Graduate Degree Works Worksheet** each semester to monitor degree program requirements and progress
- Students should only register for courses that appear as valid options in the **Worksheet** shown as "**Still Needed**" and should also review applicable non-course requirements:
 - Only a fully approved course substitution, submitted by the student using eForms and approved by the adviser, academic unit, and the Office of Graduate Academic Affairs will appear on the Worksheet
 - An unapproved course is not applicable and will appear in the Falthrough section of the Worksheet
 - Unapproved courses shown in the Falthrough section on the Worksheet may be denied for program use
 - A change of program, declaration of a specialization, concentration, project, or thesis option will change the degree program requirements
 - Students will file an eForm and obtain final approval before completing registration for any course that does not appear as "**Still Needed**" in the Worksheet
 - Consider using the **What-If Audit** feature to consider a change to the degree program, program options, or catalog (bulletin) year

- Consider using the **Look Ahead** feature to determine if courses of interest will apply to the degree program requirements
- Courses that appear in the Fallthrough section of Graduate Degree Works do not explicitly meet the degree program requirements. If this occurs, request special consideration of these courses as a substitution or exception using eForms, which is accessed by clicking the “eForms” tab at the top of the Worksheet
- Approval of course exceptions and substitutions is at the discretion of the adviser and academic unit approver with final approval required by the Office of Graduate Academic Affairs

eForms for Degree Works

eForms for Degree Works facilitates the submission, review, and approval of requests to make changes to a degree program that is in-progress. Students initiate a request by selecting the **eForms** tab in **Graduate Degree Works**. Only one eForm can be filed and reviewed at a time. eForms requests include:

- Change of Adviser
- Change in Degree Program (within the same academic unit, and same or lower level degree type)
- Co-terminal program course approvals for
 - Shared 400- and 500-level+ courses for both undergraduate and graduate program use
 - Non-shared 400- and 500-level+ courses for exclusive use in the graduate program
 - Non-shared 500-level+ courses for exclusive use in the undergraduate program
- Accelerated master’s program shared course approvals (from Illinois Tech undergraduate degree)
 - For new graduate students admitted beginning Fall 2019 semester or later
- Declare a Specialization or Concentration
- Declare an International Research Project (INIP). For IIT Europe Students only (see International Partner Research Project section (p. 558)).
- Declare a Research Project or Thesis Option
- Transfer credit approval
 - External (other institution’s course)
 - Internal (other academic unit’s course)
- Course substitution or exception approval
 - Course(s) of interest that do not explicitly meet the program requirements shown on the Graduate Degree Works Worksheet
 - Courses that appear in the Fallthrough section of Graduate Degree Works (these may be denied since approval was not requested before the course was completed)

Updating Program Options

Degree programs may have mandatory or optional specializations, concentrations, project, or thesis options. In all cases, the Graduate Degree Works Worksheet will display when program options are available for the program in-progress. eForms in Graduate Degree Works is used to submit a declaration of a program option and to obtain approval. Once the program option has received final approval from the Office of Graduate Academic Affairs, that change will be reflected in the student’s record and in the Graduate Degree Works Worksheet.

When to Submit a New Application

A new admission is required and should be filed with the Office of Graduate Admission (admissions.iit.edu/graduate) when the student seeks:

- A change to any degree program from a different academic unit
- A change to any co-terminal degree program pairing (even within the same academic unit)
- Admission to a Master of Science (M.S.) when currently admitted to any other master’s program within the same academic unit
- Admission to any Ph.D. program when currently admitted to any master’s program

International Advising

Students with any immigration-related questions should consult the International Center (iit.edu/international-center) for advice to ensure current policies and procedures are considered. Academic advisers should never be asked to provide immigration advice.

Financial Aid Advising

Students with any financial aid-related question should consult the Office of Financial Aid (iit.edu/financial-aid) for advice to ensure current policies and procedures relevant to the student’s specific inquiry are considered. Academic advisers should never be asked to provide financial aid advice.

English Language Deficiencies, Assessment, Courses, and Waivers

English competency requirements are published in the Graduate Bulletin in the Graduate Admission section (p. 11).

Students who are admitted with English language deficiencies are notified of these by the Office of Graduate Admission during the admission process. The Graduate Degree Works Worksheet also displays when a student has Proficiency of English Language (PESL) course requirements. All incoming students with English language deficiencies are required to complete an English assessment, administered by English Language Services (ELS), upon arrival and before the first week of classes for course placement. The only method by which a student may obtain a waiver of a specific PESL course requirement is by obtaining the requisite score for proficiency during the assessment.

Questions regarding the assessment process should be referred to English Language Services (english.iit.edu).

Co-Terminal Eligibility and Advising

Co-terminal degrees can be formal degree pairings, or students may choose to work with advisers to identify alternate bachelor's and master's degree pairings, pending the approval of the prospective graduate program and the student's undergraduate program. For more information on the university's legacy co-terminal degree pairings, please see the Co-Terminal Degree Programs section (p. 27) of this bulletin. These programs are also known as Accelerated Masters Programs, specifically see AMP-CT, under section 7.1.1.

Declaration of Intent

Students who wish to enroll in a co-terminal program should file a Declaration of Intent as early as their first semester of enrollment at the university. This declaration signals an intent to apply to a co-terminal program in the student's junior year, should academic criteria be met. This declaration is especially critical for students who wish to pursue a customized co-terminal degree pairing and will help identify any deficiencies or prerequisite courses for the prospective graduate degree program. The Office of Undergraduate Academic Affairs will monitor the student's declaration until such time as the student may apply to be fully admitted to a co-terminal master's degree in their junior year, subject to the admission policies of the graduate academic unit.

Co-Terminal Shared and Non-Shared Credit Form

Co-terminal students have a mandatory academic advising session with their co-terminal adviser during the first semester of co-terminal enrollment. The advising session is scheduled by the co-terminal student with the assigned co-terminal graduate program adviser. In order to ensure compliance, a Graduate Co-terminal Hold is placed on the student's registration.

The adviser and student will review the Graduate Degree Works Worksheet and identify which courses can be shared between the undergraduate and graduate degree programs, if this has not previously been determined. The adviser will also make recommendations about other non-shared courses for exclusive graduate program use. The student may also consider if some 500-level courses should be designated for exclusive undergraduate program use.

To declare the courses to be completed during the co-terminal program, the student should select the **eForms** tab in **Graduate Degree Works** and submit the **Co-Terminal Shared and Non-Shared Credit** form. The form must be fully approved by the co-terminal adviser, academic unit approver, and the Office of Graduate Academic Affairs. The GC (Graduate Co-terminal) Shared Credit Hold will be lifted by the Office of Graduate Academic Affairs once the selected courses are fully approved to allow student registration.

Once approved, in progress-courses may not display in the student's Graduate Degree Works Worksheet. Once the course is completed, a graduate level is added to the course which allows the semester and cumulative graduate GPA to be calculated and the graduate transcript and degree audit to be created.

Students are expected to follow the approved courses from the eForms declaration; however, co-terminal students in a paired co-terminal program may request changes to their co-terminal non-shared and shared credit by filing an eForm Course Substitution and Exception request articulating the original approved course and the desired course replacement. Approval of a requested substitution is at the discretion of the co-terminal adviser and academic unit approver, with final approval by the Office of Graduate Academic Affairs. As grades are entered each semester, all approved shared credits and all non-shared 500-level courses (not declared as exclusive for undergraduate program use) will be converted to a graduate-level. **Note: Co-Terminal students enrolled in unpaired degree programs may not seek modifications to the graduate program requirements through course substitution and exception. The graduate degree requirements will be followed explicitly as published in this bulletin, inclusive of approved shared credit.**

Accelerated Master's Program (AMP) Eligibility and Advising

Alumni who wish to pursue an Illinois Tech master's degree after attaining their Illinois Tech bachelor's degree (within three years of conferral) may apply to a master's degree with advanced standing. Through the Accelerated Master's Program (AMP-AS), students may share up to nine credit hours of applicable undergraduate coursework with their Illinois Tech master's degree, pending the approval of the graduate program. For more information, please see the Transfer Credit section (p. 560) of this bulletin.

Undergraduate students who wish to pursue an Accelerated Master's Program (AMP-CT) concurrently with the bachelor's degree in-progress will follow the graduate admission and shared credit policies for co-terminal studies (p. 35).

Detailed information regarding the AMP-CT and AMP-AS programs are found here (see section 7.1.1).

Accelerated Master's Shared Credit Form

In the first semester of graduate enrollment, the student is required to file an eForm through Graduate Degree Works to request internal transfer credit from the undergraduate degree program course history. Courses must meet the explicit degree requirements, as displayed in the Degree Works Audit Worksheet, and have a minimum earned grade of "B". Courses earned with an "S" grade may only be considered for 594 project research credit.

Interdisciplinary Program Advising

Students who are admitted to an interdisciplinary engineering program will receive advising from the admitting academic unit, which assigns the academic adviser (see the Armour College bulletin page (p. 42) for a full listing of engineering interdisciplinary programs).

A concentration code for the interdisciplinary track is attached to the student record by the Office of Graduate Admission, and that code generates the program requirements displayed in the Graduate Degree Works Worksheet. Students do not file an eForm to declare the interdisciplinary concentration track for these programs.

When the interdisciplinary degree is earned, only the degree title will appear on the student's diploma. Both the degree title and concentration track will appear on the official transcript.

International Partner Research Project

A student who is admitted to a dual degree program with Illinois Tech and a European partner institution may have a requirement (or option) to complete a research project to satisfy the home institution's degree requirements. This research may not be directly applicable to the Illinois Tech master's project or thesis research requirements.

The student must declare when the International Partner Research Project (INIP) is required, or desired, during the first semester of enrollment at Illinois Tech. Declaration of the INIP is completed from Graduate Degree Works by selecting the eForms tab, then selecting the Change Program option. The INIP program option request must be approved by the Illinois Tech academic adviser and academic unit approver, with final approval by the Office of Graduate Academic Affairs.

The student is required to reserve at least one required credit hour of registration at Illinois Tech for use during the summer session, when INIP research is being conducted during that term. The student must also file for summer graduation (not spring) when INIP research will be conducted during the summer term. If the student fails to declare the INIP, and/or the Illinois Tech degree requirements are satisfied in the spring semester, the student will lose the opportunity to complete an INIP when the Illinois Tech degree is conferred.

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 Student Handbook (web.iit.edu/student-affairs/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.

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. In certain cases, a Remediation Plan may be required as advised by the Graduate College and at the discretion of the academic unit. 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 major GPA in his or her program is below 3.0, then graduate courses 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. The grades for those courses which appear in the student's Graduate Degree Works Worksheet form that fulfill the degree program requirements are used in the calculation of the GPA for graduation, which includes failed courses that may appear in the Insufficient block of the Worksheet. 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. Students should consult the section on Repeating a Course (p. 568) 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 a 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 substituted for 594 credits. Form G701 Graduate Student Petition is used to request this substitution consideration.

To initiate a request to change from a 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. 560) 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 decline course substitutions after the student has filed an application for graduation. Once a student has a completed and graded course, it may not be dropped to raise the program GPA required for graduation.

Credit by Proficiency Examination

With the prior approval of their respective advisers, academic unit heads, and the 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, and must be obtained through the Office of the Registrar (registrar@iit.edu).

Degree Program Requirements

A graduate degree will be awarded upon the completion of all degree requirements (including the required application for graduation by the deadline(s) published in the academic calendar), which may include pre-approved course exceptions.

In order to ensure compliance with approved degree requirements, master's and doctoral students must complete a required advising meeting with their academic adviser before completing nine credit hours of graduate study; doctoral students without a prior master's degree will complete a required advising meeting before completing 18 credit hours. After these deadlines, further registration may not be allowed until the required advising meeting has occurred. 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 required advising meeting can occur. 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 may not be omitted from the degree audit. The course must be repeated subject to the policies published in the Repeating a Course section (p. 568) of 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 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 the 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

Master's Transfer Credit

For master's degree programs, a maximum of nine applicable credit hours earned prior to matriculation into an Illinois Institute of Technology graduate degree program, subject to the graduate studies rules and restrictions, may be considered for:

1. External transfer credit for graduate transfer credit use. Applicable course credit hours may not have been applied toward any earned degree.
2. Internal undergraduate transfer credit from Illinois Institute of Technology.
 - a. Shared applicable undergraduate program credit (accelerated master's program).
 - b. Excess, applicable undergraduate course credit that has not been applied toward any previous degree program.
3. Shared co-terminal program credit (concurrent bachelor's and master's enrollment).

The combined limit of nine credit hours may not be exceeded for any master's degree program. The credit hours must have been passed with grades of "B" or better, and are subject to the approval of the academic unit and the Office of Graduate Academic Affairs.

Doctoral Transfer Credit

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).

Transfer Credit Submission and Approval

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 and approved by the graduate academic adviser, graduate academic department, and the Office of Graduate Academic Affairs. For more information, please see the eForms for Degree Works section (p. 556) of this bulletin.

Internal Transfer Credit

Students may request internal transfer credit for Illinois Tech courses that were either 1) graduate-level courses taken in a unit outside the student's academic unit; or 2) graduate-level courses taken during an Illinois Tech undergraduate degree program.

Students enrolled in an Accelerated Master's Program (p. 27) may share up to nine credit hours of applicable undergraduate coursework with their Illinois Tech master's degree, pending the approval of the graduate program. Students who are not enrolled in an Accelerated Master's Program may request to transfer excess undergraduate credit only.

External Transfer Credit

For external transfer credit consideration, a student should 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 (www.wes.org/evaluations-and-fees/education/graduate-admissions)

University Language Services (certified translations for transcripts not written in English) (www.universitylanguage.com/services/certified-translation/)

WES Help Center (www.wes.org/help)

Required documents by country (www.wes.org/required-documents)

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. However, a student admitted to a co-terminal program must seek a new admission, for any change of degree combination, whether for a predefined paired co-terminal program or for an unpaired co-terminal program selection (see the paragraph below for admission application details).

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 and conferral of a graduate degree requires degree-seeking admission to Illinois Institute of Technology (Illinois Tech), and prior completion of the prerequisite degree requirement, as outlined in the current Graduate Bulletin. Admitted graduate students are required to have earned the prerequisite degree(s) prior to enrollment, and to present certification of the earned degree(s) before completing any graduate degree at Illinois Tech. Students who have completed an undergraduate degree at Illinois Tech may be exempted from the degree certification policy at the discretion of the Office of Graduate Admission.

Degree certification will be completed at the time of admission, if the required documents have been provided by the student at that time. Students who have not provided this documentation at the time of admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech. The student is responsible for requesting all required official documents and for any associated costs. The university reserves the right to deny degree conferral to any student who fails to provide the required certification of official documents.

Degree-seeking graduate 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, either provided by the student, or sent directly from the institution conferring the degree to the university's Office of Graduate Admission. Students that have not provided this documentation at the time of admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech.

Degree-seeking graduate students with an earned baccalaureate degree from a foreign institution of higher learning: verification of the baccalaureate degree will be satisfied by the submission and satisfactory review of the required original documents (or copies of original documents) and English translations, either sent directly from the institution(s) conferring the degree(s), provided by the student, or provided by an accepted international credential evaluation service to the university's Office of Graduate Admission. Students who have not provided this documentation at the time of admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech. 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.

Non-degree graduate students: verification of the baccalaureate degree is not required to pursue non-degree graduate courses, but must be provided in accordance with the above criteria should a student convert to degree-seeking status. Students who have not provided this documentation at the time of degree-seeking admission must supply the required degree certifications prior to completion of the graduate degree at Illinois Tech.

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).

Credit Requirements

The Master's and Master of Engineering degrees are fulfilled by traditional graduate students 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 by traditional graduate students with a minimum of 32 credit hours earned beyond the bachelor's degree.

Two additional master's completion options are applicable to qualified students: 1) graduate transfer credit of up to nine credit hours; or 2) accelerated master's admission after bachelor's degree completion at Illinois Tech.

With academic approval, a maximum of nine credit hours, earned prior to matriculation into an Illinois Tech graduate program, may be applied to a master's degree, subject to the graduate studies rules and restrictions published in the Transfer Credit section (p. 560) of the Graduate Bulletin. In special cases, students may obtain course credit by completing a Credit by Proficiency Examination (p. 559), subject to the approval of their respective advisers, academic unit heads, and the Dean of the Graduate College.

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.

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 Graduate Degree Works Worksheet. 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 Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the 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 Dean of the Graduate College.

Master's Thesis Examination

The thesis adviser shall be the chair of the examining committee, and is responsible for all aspects of a thesis degree, including thesis advising, forms, and research credits. A thesis adviser may be any Category I faculty member from any unit provided that the person is approved by the student's departmental academic adviser and primary unit chair. A student may have up to two thesis advisers, but at most one may be from a unit outside the student's primary unit. All approved thesis advisers have joint responsibility for a student's thesis, their thesis research credits will be accepted toward the thesis requirement, and they shall be listed as thesis advisers on the final submitted thesis.

The thesis adviser shall be the chair of the thesis committee. In the case of two thesis advisers, one will be chair of the thesis committee to be chosen by mutual agreement of the thesis advisers.

In cases where there are two thesis advisers, or the thesis adviser is from a unit other than the student's primary unit, the minimal thesis committee will require one additional Category I faculty member from the student's unit.

The university also allows one external member as a committee member or co-chair. External members are experts in the field from industry, research institutions, or other universities, who have to be nominated by the committee chairs with the approval of the academic unit heads. The Dean of the Graduate College may require a short resume of an external member to establish his/her credentials.

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 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 Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the 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 mandatory advising session.
5. The results of the qualifying examination must be submitted within 15 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 Dean of the Graduate College.

Comprehensive Examination

After the approval of the mandatory advising session 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 thesis adviser shall be the chair of the examining committee, and is responsible for all aspects of a thesis degree, including thesis advising, forms, and research credits. A thesis adviser may be any Category I faculty member from any unit provided that the person is approved by the student's departmental academic adviser and primary unit chair. A student may have up to two thesis advisers, but at most one may be from a unit outside the student's primary unit. All approved thesis advisers have joint responsibility for a student's thesis, their thesis research credits will be accepted toward the thesis requirement, and they shall be listed as thesis advisers on the final submitted thesis. The thesis adviser shall be the chair of the thesis committee. In the case of two thesis advisers, one will be chair of the thesis committee to be chosen by mutual agreement of the thesis advisers. In cases where there are two thesis advisers, or the thesis adviser is from a unit other than the student's primary unit, the minimal thesis committee will require one additional Category I faculty member from the student's unit.

Three members from the committee must be from the student's major, and one 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 Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the 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. 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 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 Dean of the Graduate College. With the approval of the academic unit chair, the student's adviser must recommend the external member to the 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. Upon final submission, the signature pages and the final thesis approval form (Form G501) are checked by the thesis examiner for signatures of committee members and the academic unit head. The signatures on Form G501 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.
3. 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 G309 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, and confirmed by the thesis examiner with the degree candidate, at least nine days before the last day of the semester.
4. 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 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.

Experiential Learning

Experiential Learning (EL) allows students to apply knowledge directly to experience outside of the academic setting; EL empowers students to learn by doing. At Illinois Tech, students may pursue various types of EL including: internships, research opportunities, and much more. For more information, visit the International Center website (web.iit.edu/experiential-learning).

Policies for Graduate Students

- Graduate students enrolled in a summer internship will follow registration requirements as published by the International Center web.iit.edu/experiential-learning and must be in good academic standing (cumulative GPA 3.0/4.0). **However, registration in academic coursework is not permitted during summer semester, except in the final semester of degree completion, which is limited to 3 credit hours of on-campus academic course enrollment in the final semester.**

- Graduate students enrolled in a fall or spring internship will follow registration requirements as published by the International Center web.iit.edu/experiential-learning and must be in good academic standing (cumulative GPA 3.0/4.0). **A maximum of 15 hours of registration is allowed during the internship semester including administrative and academic course 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 an 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 an internship is concurrent with academic course registration, are not eligible for continued enrollment in an internship without prior approval of the Dean of the Graduate College.
- Graduate students, who are completing a second degree at Illinois Institute of Technology, when the first degree was also earned at Illinois Tech, are eligible for an 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 an internship after two semesters of full-time graduate enrollment, in fall and spring semesters.

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. The grades for those courses which appear in the student's Graduate Degree Works Worksheet form that fulfill the degree program requirements are used in the calculation of the GPA for graduation, which includes failed courses that may appear in the Insufficient block of the Worksheet. 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. Students should consult the section on Repeating a Course (p. 568) within the Graduate Bulletin for course repeat limitations.

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	x	x
NG	non-graded					0.00			
P	pass	x	x	x	x	0.00			
F	fail	x	x	x		0.00			
S	satisfactory	x	x	x	x	0.00			x
U	unsatisfactory	x	x	x		0.00			x
AU	audit					0.00			
W	withdrawal			x		0.00			x
X	no grade submitted			x		0.00			x

Incomplete ("I") Grade

The incomplete (I) grade is a temporary grade that must be requested in writing by the student to the instructor of record using the Incomplete Grade Request Form.

- The student must have substantial equity in the course as determined by the instructor.
- The student must complete the Incomplete Grade Request form online and submit the form to the instructor of record for review and approval. The form must be submitted prior to the week of final examinations.

- The request for an incomplete grade is to be approved by the instructor only in cases of illness or for unforeseeable circumstances that prevented the student from completing the course requirements by the end of the term.
- There must be a written agreement between the student and the instructor detailing the remaining requirements to complete the course.
- The Office of the Registrar will post the incomplete grade upon receipt of the approval from the instructor. Directions for the instructor on how to send the approval to the Office of the Registrar are provided in the email request from the student.
- Once remaining requirements have been completed, the instructor must submit a Change of Grade Request Form (available in the "Office of the Registrar—Faculty and Staff Resources" channel under the Teaching tab of the myIIT portal) to change the incomplete grade to a final grade by the deadline indicated on the Academic Calendar. Any remaining incomplete grades will automatically be converted to a failing grade (E, U, or F).
- If additional time is needed to complete the remaining requirements, students may request an extension with the instructor. If approved, the instructor will contact the Office of the Registrar to apply the extension (7th Monday of the following semester, excluding summer). Only one extension can be granted. If the extension is granted, then the instructor will be allowed to submit the Change of Grade Request Form by the new (extended) deadline as indicated on the Academic Calendar.
- The instructor cannot request that an incomplete grade be given for a student without the student first requesting it. If there is no request by the student, then the incomplete grade will not be applied.

Research ("R") Grade

Applicable only to approved research courses, the grade of "R" may be assigned for students who have not completed research work in the course. Once assigned, the grade of "R" will remain on the student's transcript until the research as determined by the research professor is completed and changed to a final grade of Satisfactory ("S") or Unsatisfactory ("U"). The grade of "R" does not fulfill the requirements of a graduate program.

Non-Attendance ("NA") Grade

A grade of "NA" indicates an apparent withdrawal as a result of the student never attending a registered section. The "NA" grade was designated as a final grade equivalent to a failing grade of "E" and calculated in the graduate cumulative GPA through Summer 2015. The designation changed in Fall 2015 by which the "NA" grade is a midterm grade only and, therefore, does not impact the graduate cumulative GPA.

Withdrawal ("W") Grade

The withdrawal grade is issued to students who withdraw from a class after the last day to add and drop classes. The "W" cannot be changed to a standard letter grade and does not fulfill the requirements of a graduate program.

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. The grade of "U" does not fulfill the requirements of a graduate program.

Audit ("AU") grade

Auditing of courses is discouraged, but a student may do so if the student 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 add/drop deadline. 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 only to faculty and authorized academic administrators in the myIIT portal on the Teaching tab in the Office of the Registrar Faculty and Staff Resources channel. 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 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.

A student may appeal the final grade received for a course directly with the instructor. If approved, then the instructor will submit the request for an official change of grade.

- All grade changes must be initiated by the instructor of record or the authorized academic administrator using the online Change of Grade Request Form available in the "Office of the Registrar—Faculty and Staff Resources" channel under the Teaching tab of the myIIT portal. Emails and paper forms are not accepted.

- A final grade ("A", "B", "C", "D", "E", "AU", "P", "F", "S", "U", "NG", or "W") cannot be changed to a temporary grade ("I", "R", or "X"). For more information regarding the grade marks, consult the official Grade Legend.
- Grade changes submitted within four weeks of the end date of the term require only the approval of the instructor. Grade changes submitted after four weeks of the end date of the term will require additional approvals from the department chair, academic college dean, and vice provost for Academic Affairs.

Repeating a Course

Students may repeat up to two distinct courses during an academic career as a graduate student with each course being repeated only once. Both grades will be recorded onto the student's academic transcript, and the grade used in the calculation of the cumulative GPA will be the latest recorded, except when the last recorded grade is W (withdrawn) or AU (audit).

To repeat a course, students must first register for the course and then submit the Graduate Course Repeat Request Form which requires the permission of the student's adviser and the Dean of the Graduate College. This form is accessible from the Office of the Registrar website: web.iit.edu/registrar/registration/course-repeat-policy.

Students who are on academic probation may request to repeat a course using the G702 Academic Probation Contract which requires the permission of the student's adviser and the Dean of the Graduate College. This form is accessible from the Office of Graduate Academic Affairs website: web.iit.edu/gaa/students/student-forms.

Transcripts

Official transcripts are requested through the Office of the Registrar and are only released with the 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 when holds on accounts are cleared. Official transcripts are either mailed, sent electronically (PDF), or made available for pickup by the student. Official transcripts issued directly to the student making the request are stamped "ISSUED TO STUDENT." A fee is charged for each transcript issued.

The Office of the Registrar does not provide unofficial transcripts. Students and alumni may access their unofficial transcripts through the myIIT portal in Banner Self Service.

For more information, visit web.iit.edu/registrar/transcripts.

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 complete a mandatory advising session with their academic unit. 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 section (p. 33) for a list of steps and corresponding forms that must be completed. Detailed degree-specific requirements are listed under the relevant academic unit in this bulletin. General information may also be found in the Degree Program Requirements section (p. 560) of the bulletin.

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 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. 570) as published in the Graduate Bulletin. The M.S. Comprehensive (Thesis) Examination may also serve the purpose of revalidating the outdated courses.

Doctoral Candidates

Doctoral study must be completed within six years of the mandatory doctoral advising session, which occurs at 18 earned and/or enrolled credit hours. Any courses that are completed outside of 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. 570) as published in the Graduate Bulletin, when required prior to the Ph.D. Comprehensive Examination.

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 submitted to the Office of Graduate Academic Affairs, by the deadline listed in the Academic Calendar for the semester of graduation. See the Degree Program Requirements section (p. 560) 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, which must be approved by the Office of Graduate Academic Affairs.

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 classes, 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 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 of the credits or courses may be specialized (topical) accelerated courses. Transfer credit cannot be applied toward a graduate certificate.

The time limit for certificate 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 (in a single certificate program) 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, except while degrees are being conferred during the last two weeks preceding the degree conferral date as published in the academic calendar. The student will not receive their 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 mandatory doctoral advising session. 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 completed courses 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 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 to be revalidated should be attached to Form G504 and submitted with the petition for extension.

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 for up to one additional year may be submitted by filing a Form G701 Graduate Student Petition. Students who wish to be reinstated after a two year approved leave has lapsed must submit a new application for graduate admission. **Leave of Absence for Health:** Before a student pursues a leave of absence for health reasons, they should first secure documentation from the medical provider, which must be submitted to the Office of the Dean of Students for evaluation. Once the Office of the Dean of Students confirms the Leave of Absence for Health is approved, the student may proceed to file the online Leave of Absence Form and include Leave Health as the reason. If that protocol is not followed, the reason must be recorded as a Leave Personal.

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 (unless there is an extenuating health issue). A student who has not renewed their leave of absence must petition for reinstatement to the Office of Graduate Academic Affairs for an extension. 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. 560) 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. 560) of the Graduate Bulletin.

Note: Students who wish to be reinstated after a two year approved leave of absence has lapsed must submit a new application for graduate admission.

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 for more details.
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 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 Dean of the Graduate College for approval.

An international student on an 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 enrollment is allowed with the approval of the academic unit and the International Center. If the student has an appointment as a TA or RA, they are 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

Academic Degree and Certificate Programs

000 - 099	No Credit
100 - 299	First and Second Year Undergraduate Level Courses
300 - 399	Third Year Undergraduate Level Courses
400 - 499	Advanced Undergraduate and Introductory Graduate Level Courses
500 - 699	Graduate Level Courses
700 - 799	Intensive Graduate Level Courses

Continuing Education Level (CEU) Programs

IEP 001 - 999	Intensive English Program Courses
PL 001 - 999	Professional Learning Program Courses
SC 001 - 999	Short Continuing Education Courses
SCO 001 - 999	Short Continuing Education Courses (Online)
800 - 899	Applied Technology Certificate Program Courses

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 an electronic permit from their faculty adviser and then proceed to register for the course in Banner Self Service in the myIIT portal.

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. This permit will be issued once.

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 fall or spring semester or during the first week of the summer semester for 100% refund of tuition and course fees. A course may be withdrawn with no refund of tuition and course fees 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 processed 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 Office of Student Accounting (sa@iit.edu, 312.567.3794). 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. 571).)

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. Permission from the academic department may be required to override level restrictions on the course and to allow registration.

An undergraduate student registering for more than nine credit hours of graduate courses must also obtain written approval from the 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 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 or accelerated master's degree program admission. Students should consult the rules for transfer of credit under the Transfer Credit section (p. 560) of the Graduate Bulletin.

Note: Students admitted to co-terminal undergraduate and graduate studies should review the Synopsis of Co-Terminal Studies (p. 35) 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 Dean of the Graduate College. No more than six credit hours of accelerated courses may be included in a master's degree program. Accelerated courses can be selectively included in a Ph.D. program 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 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 are granted an official leave of absence from the Office of Graduate Academic Affairs (see the Leaves and Withdrawals section (p. 570) of the Graduate Bulletin for more information). 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 Registration section (p. 571) of 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 Graduate Thesis Manual, available online at bulletin.iit.edu/graduate-thesis-manual.

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 second draft. A third meeting is necessary for approval of the final draft; however, additional meetings may be required. Based on the third review, it is up to the discretion of thesis examiner to determine how many additional meetings will be necessary.

The final 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. Requests for extension of thesis deadlines will be declined, and degree candidacy will be deferred to the following semester.

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 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
arc@iit.edu
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, peer advising, group study space, and an OTS computer laboratory, including PCs and Macs. Additionally, the ARC keeps some textbooks and iPads with academic apps for reference. The tutoring schedules are available online and students can make an appointment utilizing the TutorTrac system (tutortrac.iit.edu).

The peer ARC Scholars will assist with academic software, such as: Java, Javascript, Excel, SPSS, MATLAB, Mathematica, AutoCAD and more. The ARC's focus is towards undergraduate courses at Illinois Institute of Technology. Graduate students can also 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.

Athletics and Recreation

Keating Sports Center
312.567.3242
illinoistechathletics.com

Intercollegiate Athletics

Illinois Institute of Technology is a full member of NCAA Division III for all varsity sports. 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 tennis, men's and women's indoor track and field, men's and women's outdoor track and field, men's and women's lacrosse, and baseball.

As a member of NCAA Division III, Scarlet Hawk student-athletes have the opportunity to face strong competition from other Division III members. Illinois Tech is a member of the Northern Athletics Collegiate Conference (NACC) in all sponsored sports except men's and women's swimming and diving.

The Illinois Institute of Technology's 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 Technology has the only disc golf course in the city of Chicago, making the campus a popular destination for local disc golf enthusiasts.

Access, Card, and Parking Services

Hermann Hall, Room 201
312.567.8968
acaps@iit.edu
iit.edu/acaps

Access, Card, and Parking Services (ACaPS) is the home of the HawkCard. The HawkCard is the photo identification card for Illinois Tech students, faculty, and staff. It also grants access to buildings, parking lots, computer labs, Keating Sports Center, library services, resident meal plans, and TechCash balances. Students can check their meal plan balances, add TechCash, and report their HawkCard lost online via MyHawkCard. Parking permits are available for purchase online via MyParking. Visit the ACaPS Office in Hermann Hall, Room 201 or contact the team at 312.567.8968 or acaps@iit.edu with any questions.

Campus Life

McCormick Tribune Campus Center, Room 208
312.567.3720
/web.iit.edu/campus-life/about-us

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), first year experience programming, and student leadership development and supports spiritual and diversity-related programming. In addition, it also provides direct oversight to more than 150 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
careerservices@iit.edu
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
- access to career development technology resources such as our internal job posting board, Handshake
- career fairs and other recruitment or networking events to engage with employers

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, and the School of Applied Technology. More information is available on the Career Services website. Separate career support offices exist for the Institute of Design, Stuart School of Business, and Chicago-Kent College of Law.

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 Illinois Tech 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 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 also periodically reviews all C-courses in each academic unit to ensure that they meet the university's standards for such courses. Finally, the CAC 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

10 W. 35th Street, Suite 3F3-1
312.567.5744
disabilities@iit.edu
iit.edu/cdr

Services for people with disabilities are coordinated by the Center for Disability Resources (CDR). 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.

English Language Services

IIT Tower, 4th Floor
10 West 35th Street
312.567.5220
els@iit.edu
english.iit.edu

The mission of English Language Services at Illinois Institute of Technology is to provide engaging English language instruction in a dynamic learning environment relevant to the academic and professional needs of non-native learners.

English Language Services offers several options for students to develop their language abilities. To view more information about the English Language Services department and what they offer, please visit english.iit.edu. English Language Services is accredited by CEA (the Commission on English Language Program Accreditation), and under the university through the Higher Learning Commission (HLC), and is licensed to operate under the Illinois Board of Higher Education.

To view information about specific programs and courses, please visit the Language Courses section (p. 36) of this bulletin. Programs include:

- Intensive English and Pathway Program
- English Language Program (commonly referred to as PESL)
- Professional Communication Advancement
- English for Design

English Language Services also offers special programs/courses for visiting groups as well as individuals who want to study part-time. Contact us at els@iit.edu to find out more.

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 two 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

IIT Tower, Suite 7D7-1
312.567.3024
gradcoll@iit.edu
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.

Services provided by this office include the review and approval of requests for transfer credit; change of degree and major; declaration or change of specialization, project, and thesis option; approval of master of science and doctoral examination results; acceptance of the application for graduation, certification of the graduate degree; completion of the academic probation meeting; approval of an official leave of absence or official withdrawal from the university; and reinstatement of a former student to graduate study. Graduate Degree Works, the online degree audit system is monitored and maintained by GAA.

Note: The Graduate College (GC) reviews and makes the final decision for the Graduate Student Petition (Form G701), the Academic Probation Contract (Form G702), and academic dismissal action as well as monitors and maintains this bulletin. The college also provides both optional and mandatory thesis workshops, as well as preliminary and final thesis examinations.

Idea Shop

ipro.iit.edu/ideashop

A catalyst for innovation, the Grainger Maker Space and the Duchossois Idea Shop facility is composed of state-of-the-art rapid prototyping labs that include 3D printers, CNC mills, electronics workstations and many hand fabrication tools; a Dell laptop lab; an iPad library; a computer 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 Grainger Maker Space and Duchossois Idea Shop are located in the Ed Kaplan Family Institute for Innovation and Entrepreneurship.

International Center

McCormick Tribune Campus Center, Room 106
312.567.3680
icenter@iit.edu
iit.edu/international-center

The International Center exists in order to provide professional support, services, and resources to the Illinois Tech community in matters related to international education and cultural exchange by 1) supporting international students, faculty, and staff, as well as students studying abroad; and 2) assisting in the compliance of immigration and other related regulations.

These services include:

- Individual and group orientations to the university and community
- Assistance with United States Department of Homeland Security and U.S. Department of State document preparation for employment, and status maintenance
- 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
- Advisement for students interested in studying abroad

All international students, scholars, and faculty are required to report to the International Center immediately upon arrival into the U.S./ Chicago.

Interprofessional Projects

3137 South Federal Street
ipro@iit.edu
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 six 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

312.567.6847
library@iit.edu
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

312.567.6847
library.iit.edu

As the university's central library, Paul V. Galvin Library combines digital access with traditional library services. Galvin Library provides welcoming, safe, student-oriented spaces that accommodate both individual and collaborative learning including reservable group study rooms and spaces for students participating in interviews or video conferences. In addition to 3-D printing, Galvin Library facilitates the use of an electronic cutter and button makers for student and student group use. Laptops and Wi-Fi hotspots are available for check-out in addition to traditional library resources. Galvin Library's extensive collections of print materials are enhanced by virtual services that are provided 24 hours per day allowing seamless access to online databases as well as thousands of full text e-journals and e-books. Galvin Library also facilitates access to I-Share, a statewide resource sharing system of more than 90 academic libraries, and provides web-based delivery of materials via interlibrary loan. Galvin Library also manages an institutional repository, open to all Illinois Tech students. Librarians have expertise to support a broad range of subjects and majors and are available for online or in-person assistance. Students can make research appointments for one-on-one research help with a librarian who specializes in their area of study.

Graham Resource Center

312.567.3256
arch.iit.edu/about/library

Located in the heart of Crown Hall, the Graham Resource Center (GRC) offers space, collections, and services in support of the curricula and intellectual life of the College of Architecture. To keep services flexible and responsive to learners' needs, staff collaborate closely with faculty. To be a strong and reliable partner in research and education, the GRC is fully integrated into daily life at the College of Architecture.

In the past ten years, the GRC has expanded twice in order to accommodate growing use and collections. A wealth of subjects in architecture, from prehistory to the present, are encompassed by the collection of about 18,000 volumes in a variety of languages and formats. Modernist and contemporary architecture, landscape architecture, and urban design are primary focuses. Complementary disciplines such as construction, art, photography and film, engineering, and sustainability are also well-represented.

Two special research resources augment the GRC reference collections: works on Chicago's history, peoples, land, and architecture comprise the first, putting into context Chicago and its built environment; the second, our "Mies Collection," features a comprehensive Mies van der Rohe bibliography and study collection, as well as materials relating to the history of Illinois Tech's campus and faculty.

Center for the Study of Ethics in the Professions

312.567.6913
ethics.iit.edu

The center, located on the 14th floor of the IIT Tower, 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

Chicago-Kent Law Library offers a comfortable library center for study and research with a skilled and friendly staff to support student academic life and faculty scholarship. Professional law librarians possess the expertise to provide research and reference assistance in all areas of law and legal technology training through in-class presentations and personal assistance. The library offers multi-disciplinary print and electronic collections and connects students and faculty to an expanded array of materials through a statewide resource-sharing system and interlibrary loan. Through the library's website, the law school community has remote access to a wide variety of legal

databases collections and electronic journals. Library space includes a spacious reading room for independent study and group study rooms for collaborative work.

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 and Special Collections

312.567.6840

archives.iit.edu

Part of the Paul V. Galvin Library, University Archives and 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

IIT Tower, Suite 2C7-2

312.567.3777

idee@iit.edu (scdi@iit.edu)

Mission

The Office of Inclusion, Diversity, and Employer Engagement (IDE²) serves as a catalyst to connect industry, individuals, and communities in support of education and career preparation that is respectful, responsible, and professional.

Vision

Our overarching lens will be one of diversity and inclusion in our approach to creating a comprehensive network of opportunities that will broaden mindsets, yield growth, provide and transition support. IDE² 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, traditions, academic disciplines, and personal experiences. Through this process we also learn about our own values and strengths, deepening our ability to promote, take intentional action, and express empathy.

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 individual needs of scholars. 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 worldwide. 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 inside the classroom and beyond.

Student Engagement

We are committed to enlightening and empowering students so that they are comfortable undertaking responsibility. Students can use their honored positions to serve others and contribute to broader movements of engagement. We value students' 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 lean toward the privileged majority and dominant groups. Without the intentional actions of individuals, the needs of those with fewer resources are disregarded. We believe that there are enough resources to meet the basic needs of all, which enables 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 that support freedom of thought, inquiry, and expression.

Key Pillars

We are committed to excellence and quality in all of our endeavors. Three key pillars have been identified to provide strength and support for our vision:

- Pillar 1: Employer and Alumni Engagement
- Pillar 2: Core Initiatives and Programs
- Pillar 3: Transformative Student Experience

Signature Initiatives

- **Professional Student Organizations (PSOs) and Honor Societies** – A network program that supports a responsive academic-industry partnership for students and compliments the classroom experience.
- **Illumination Sessions** – This program is a platform where primarily alumni from companies are able to come to campus and share insight on business culture and the workplace environment to better prepare students for the workforce.
- **Alumni Career Voices** – A collection and sharing of alumni career experiences through statements internally and externally.
- **Diversity and Inclusion Council** – A brain trust of advisers comprised of volunteers from corporations and nonprofit sector leaders who meet on a quarterly basis to share best practices.
- **Diversity Research Scholars (DRS)** – Internships are provided to college students from other institutions to research diversity in the workplace at Illinois Institute of Technology. The program takes an insightful look into federal, state, and local diversity laws that impact workplace hiring, promotion, and retention practices.

Programs

- **Industry Sharing Table** – A bridge that provides faculty, alumni, departments, and companies with a connection to each other and students for the purpose of exchanging ideas and information.

Resources

- **True North Career Guides** – Library guides that provide inclusive resources for marginalized groups in support of individual career planning.

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. Our knowledgeable and helpful staff are dedicated to providing courteous and professional service.

Requests or questions about student records and registration should be directed to the Office of the Registrar at registrar@iit.edu. Illinois Tech faculty, staff, and students should use their Illinois Tech email address when contacting the office.

The Chicago-Kent College of Law Registrar's Office can be reached at REGQ@kentlaw.iit.edu or 312.906.5080.

Residence Life

3241 S. Wabash Ave., Suite 110
312.567.5075
housing@iit.edu
iit.edu/housing

On-campus housing is available to both undergraduate and graduate students. First-year and second-year students not living with their parents or guardians within a 20 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.

The Office of Residence Life (ORL) offers a wide range of accommodations, programs, and services designed to enhance campus life. Housing options vary from shared dormitory style rooms to fully furnished apartments with kitchens. ORL maintains residence halls 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 the Office of Residence Life at housing@iit.edu or visit the website at iit.edu/housing.

Student Affairs

McCormick Tribune Campus Center, Room 209
312.567.3081
dos@iit.edu
iit.edu/student-affairs

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 (web.iit.edu/student-affairs/handbook).

The Office of Student Affairs oversees many areas of student life and provides advocacy for all Illinois Tech students. The office also oversees the student conduct process. Students, faculty, and staff are encouraged to contact the office for help or referrals.

Student Health and Wellness Center

IIT Tower, 3rd Floor
312.567.7550
Appointments
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. The SHWC provides administrative oversight of the Aetna Student Health Insurance Plan provided to students registered for one or more academic credit hours. Health insurance is not required to use the SHWC. Students are able to schedule medical and counseling appointments through the Patient Portal.

SHWC provides diagnosis and treatment of most common illnesses and injuries with the ability to provide appropriate prescriptions. Immunizations, allergy injections, gynecological care, sexual health screening, and walk-in appointments are also provided. A small fee may incur for labs, diagnostic tests, immunizations, and medication given on site.

Counseling services include individual and group psychotherapy, community referrals, and medication management. Treatment length varies depending on individual needs. 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 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, the myIIT.edu portal, Banner, and the network and telephone infrastructures. OTS also supports the HAWKi mobile application, which was developed in partnership with the Student Government Association who provided their input in the design, content selection, and naming of the app. With HAWKi, many useful resources are at students' fingertips; students can: (1) view course assignments, class rosters, grades, discussions, 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 to reflect students' needs and desires.

OTS maintains approximately 579 workstations 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 supports their academic goals, OTS offers laptops and MiFi-devices for checkout through the Galvin Library Circulation Desk. Additionally, the computers in the classrooms and labs are refreshed on a regular basis. 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 (my.iit.edu), 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 their Google Apps for Education account, which is accessed via the portal. Google Apps for Education also includes collaboration tools such as Google Docs, Sheets, Meet, Chat, Sites, Groups, and more. Course material is available through Blackboard, Illinois Tech's course management system, wherein instructors post lectures, notes, assignments, and other course information. Blackboard Collaborate and other interactive tools within Blackboard Learn are available to enhance students' learning experience. Illinois Tech's distance-learning content and video lectures are also accessed through Blackboard.

The university provides 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 Wi-Fi networks, which cover 100% of the occupied and used space on campus. 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.

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.

Visit the OTS website for the most up-to-date information and useful details about the university's technology.

Undergraduate Academic Affairs

IIT Tower, Suite 2F9-1

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; 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

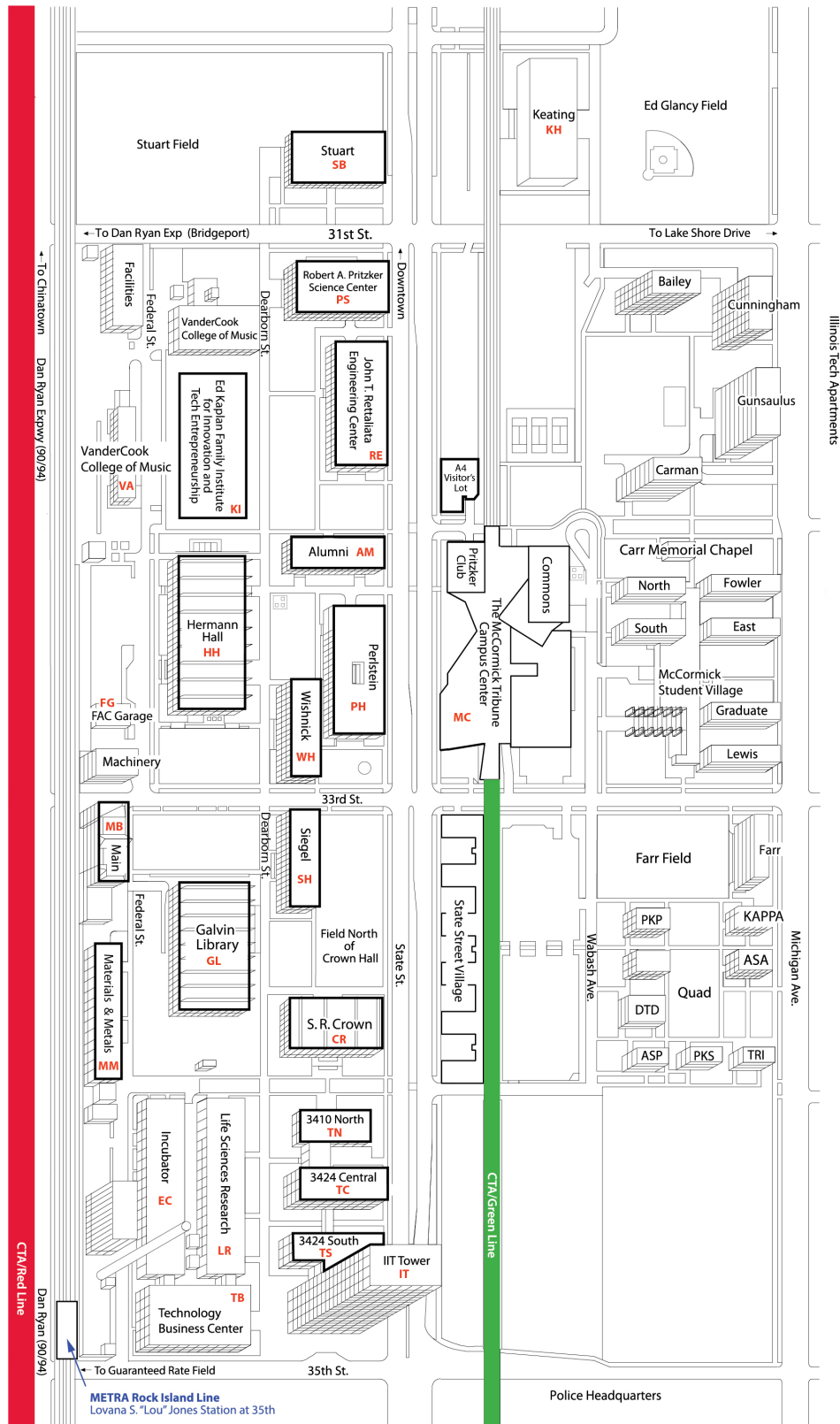
[humanities/student-resources/writing-center](#)

Students can seek assistance with written and oral assignments at the Illinois Tech 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.

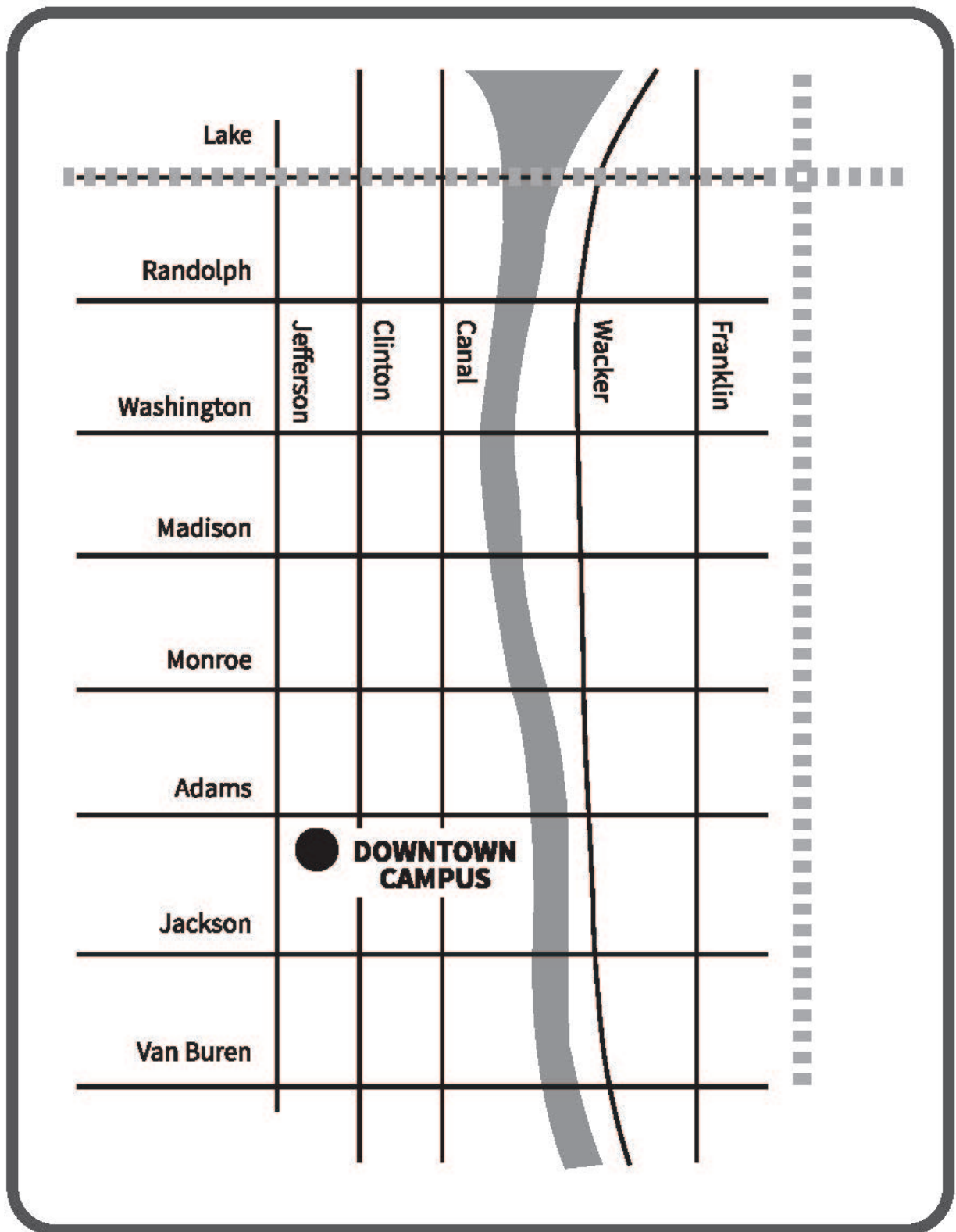
Campus Overview

Campus Resources

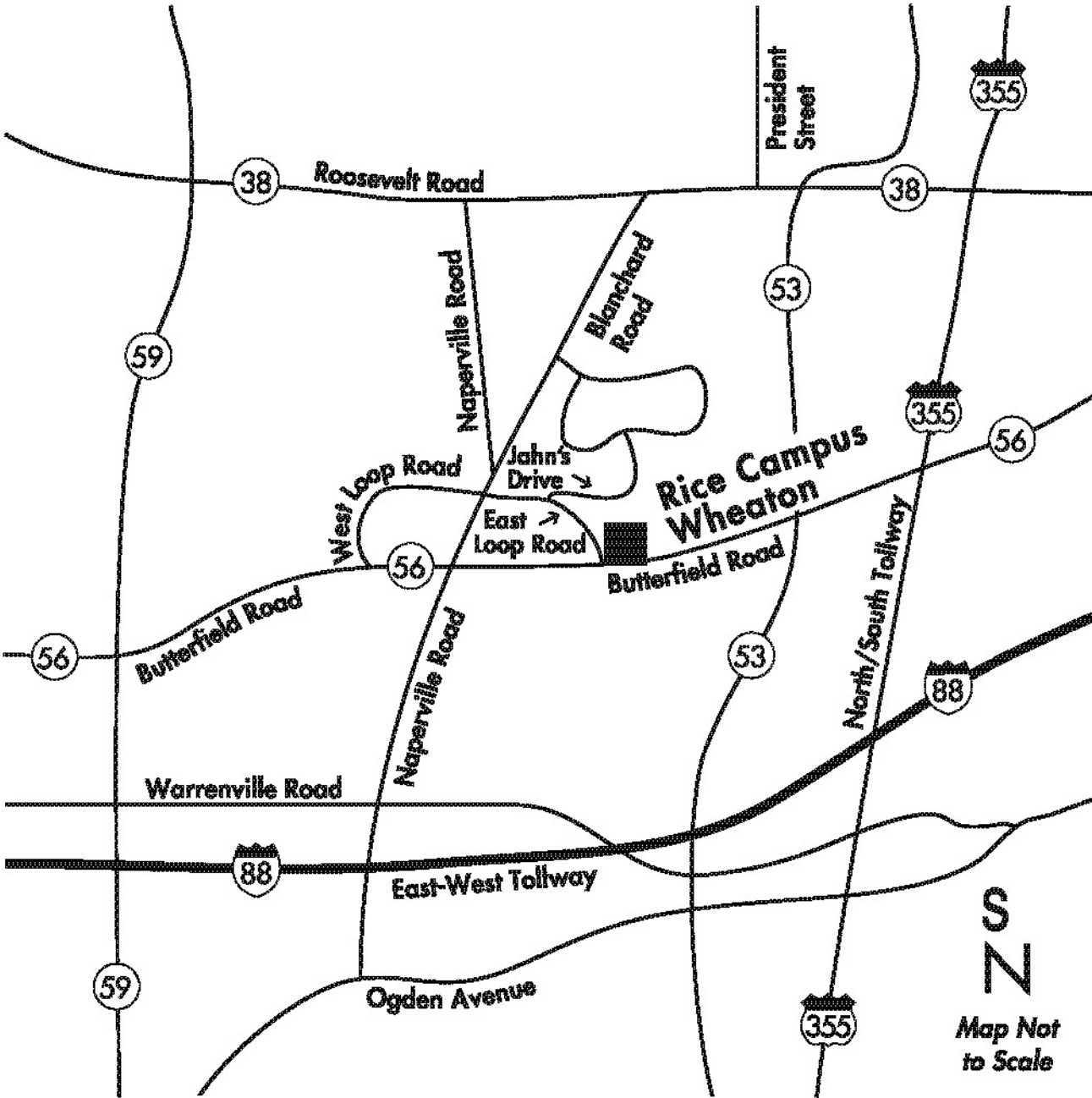
Mies Campus



Downtown Campus



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 Illinois Tech 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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